PROJECT MANAGEMENT SOFTWARE: PROPER SELECTION FOR USE WITHIN AIR FORCE SYSTEMS COMMAND

THESIS

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2

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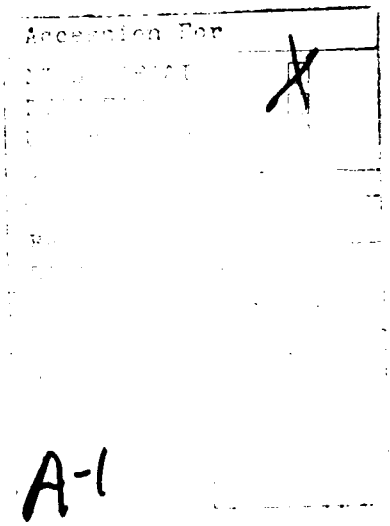

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Presented to the Faculty of the School of Systems and Logistics
of the Air Force Institute of Technology
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Requirements for the Degree of
Master of Science in Systems Management

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Preface

The purpose of this study was to evaluate the project management software systems currently available, and to determine which ones are most appropriate for Air Force use. Previous research has shown that AFSC project managers' information needs were not being met. Therefore, a detailed evaluation methodology was developed in order to find a system to meet these needs. The results present the best overall software package as a short-term solution. However, the methodology is presented as the long-term solution, since it allows for changes in technology and information needs.

There are several individuals who were instrumental to the successful completion of this study. First is my thesis advisor, Lt Col Richard Peschke, whose advise, guidance, and enthusiasm kept the study focused and my interest peaked. I would also like to thank all members of the expert panel for their generous support and recommendations. Most importantly, however, I would like to thank my wife, Amy, and our 18 month-old daughter, Jessica. A wife and best friend all in one, I thank you, sweetheart, for all your love and encouragement. And Jessica, though you may not have known it, each bright smile and heartfelt "Daddy!" helped re-align my priorities and brought me happiness and strength when I needed it most.

Robert J. Hartnett, Jr.

Table of Contents

Page

List of Figures

List of Tables

Abstract

The purpose of this study was to determine what project management software systems are available to AFSC project managers, and to determine which of these systems are most appropriate for AFSC use. The study had three basic objectives:

1. Assessing the information processing deficiencies and desires of AFSC project managers.
2. Generating a flexible project management software evaluation methodology that could be used for this and future evaluations.
3. Determining which one or group of project management software systems would best meet these information needs.

Recent research showed that the information needs of AFSC project managers were not being met. A solid project management system was found to be a possible solution; therefore, a three-phase evaluation methodology was developed. The methodology was validated by a panel of ten experts who all had considerable experience in the fields of computer systems and project management.

The methodology started with a thorough literature review, passed through a data collection phase, and concluded with the data evaluation. The data evaluation phase was broken into four stages, each designed to have more stringent requirements imposed on the software packages under consideration. The last stage called for the actual use of

each remaining software package in a manner similar to its intended use in the workplace.

The methodology was used to evaluate seventy-nine commercially available project management systems that could potentially meet AFSC needs. One system clearly stood out above the rest; however, this result could change as new software systems or versions are released. Therefore, the standout system was recommended to solve the short-term information processing problem, and the methodology used is offered as the long-term solution to inevitable future deficiencies.

PROJECT MANAGEMENT SOFTWARE:
PROPER SELECTION FOR USE WITHIN AIR FORCE SYSTEMS COMMAND

I. Introduction

Overview

This chapter discusses the information processing needs of Air Force Systems Command (AFSC) project managers, establishing the foundation for the research. The purpose of the study is then detailed, as well as the assumptions and limitations. Finally, the nucleus of the study is formed by identifying the specific research objective and investigative questions.

Background

The organic technical labor force within the United States Air Force is steadily decreasing, and has been since the early 1980s. This decline started when engineering pay bonuses were revoked (30:52). These bonuses were designed to encourage experienced engineers to stay in the military by paying them a substantial lump sum when they committed themselves to an additional four years of service in an engineering position. This option was only offered to individuals once their initial four year commitment was completed.

In an attempt to settle the ebb and flow of technical expertise, General Bernard Randolph, the commander of AFSC, has encouraged the use of temporary technical support personnel, such as those provided by the Technical Engineering and Acquisition Support (TEAS) contract, and the Scientific Engineering Technical Assistance (SETA) contract (30:52; 35:41). It is expected that the use of these consultants, instead of Air Force engineers, will provide more continuity and greater depth and breadth of experience for defense contracts.

As the organic technical labor force declines, so does the quantity and quality of information available to the project managers. Temporary technical personnel are often not located in the program office; therefore, the usual means of communication is formal tasking of the contractor to perform a study. The manager is guaranteed that the problem will be worked, but not who will be working it. This hinders the day-to-day personal contact, thus inhibiting the lines of communication. Managers are finding themselves forced to do the same job with fewer people and scarcer information. As a result, more managers are turning to relatively inexpensive computer systems which aid in streamlining their operations and filling the resultant information gap (28:89). The United States Air Force currently owns 22% of the 500 million personal computers purchased by the federal government (28:89).

Although research is limited on the use of personal computer-based information processing systems within government organizations, current studies identify two problems. First, rapid acquisition without proper planning has often rendered some systems ineffective (4:171; 15:1; 22:322). This occurs when an organization jumps on the computer bandwagon, buying whatever computer system is the most popular at the time. Upper-management often feels that the mere presence of these high-tech systems will increase productivity. However, when the need for a new system is not definitized, the purpose and proper use usually remain unclear.

The second problem is that improper planning often results in passive acceptance of the new systems by the intended users, rather than generating active user groups to aid in acceptance, implementation and training (4:171; 15:2; 22:322; 26:6). This is found when upper-management forces workers to use a newly acquired computer system. A better solution would be to give the workers a say in the acquisition process, thereby creating a sense of ownership and acceptance. This thesis takes into account these two aspects by determining the needs that the project management system is to meet, and allowing potential users to determine what is important in the acquisition process.

Purpose of the Research

This study was performed in an effort to counteract the effect of the aforementioned problems, as well as increase the acceptance of the personal computer by the managerial community. Managerial decision-making requires current, accurate information, and it is the acquisition of this high fidelity information that serves to reduce the uncertainty that project managers encounter in their ever-changing environment (1:52; 8:194). Since Air Force project managers are so heavily reliant on constantly changing information to perform their jobs effectively, this analysis is conducted from the project management standpoint.

General Issue. Since the early part of the 1980s, the Air Force has been streamlining its organizations in an attempt to increase efficiency and productivity. One way to maintain organizational effectiveness with a reduction in personnel is automation of critical organizational tasks. This automation involves an increasing reliance on personal computers. However, the mere presence of personal computers does not guarantee their effective utilization (22:313).

First hand examination of project managers within the Armament Division of AFSC, as well as research concerning project managers within the Aeronautical Systems Division, indicates that AFSC project managers are not using computers effectively to enhance their information processing capacity (23:3).

Programmatic research from three AFIT theses written by Capt Handy, Capt Smith, and 1Lt Lentini, all point to improper selection, training, and implementation of software for the personal computers as the reason for non-use of the systems (15:2; 23:3; 33:1). A broad management question can be derived from these theses that provides an impetus for follow-on research. The key issue is this: "What software is required to meet the information needs of AFSC project managers?" Meeting needs involves not only providing the correct tool, but also furnishing adequate training and support.

Specific Problem. A desire to narrow the scope and understand the variables within this management question led to the research question: "What project management software packages are available, and which are most appropriate for AFSC project management use?" This is the specific, testable question that serves as the objective of this thesis study.

Investigative Questions. Each of the following questions were addressed in order to rigorously evaluate the research question:

1. What are the current information needs of AFSC project managers?
2. What project management software currently exists that can meet these needs?
3. What are the trade-offs between the different software packages?
4. Which of the software packages available are most appropriate for use by AFSC project managers?

5. What are the best methods for properly educating project managers on the use of the recommended software?

6. What are the most effective means of implementing the recommended software and providing training throughout AFSC?

Limitations

This study was conducted using the Zenith-248 personal computer system with a color monitor and dot-matrix printer, running the MS-DOS version 3.21 operating system. The Zenith-248 is an IBM AT compatible machine; therefore, this study applies only to software which is IBM AT compatible. Additionally, the study focused only on single-user computer systems and software packages, as opposed to a computer network and multiple-user software packages. This personal computer technology was the one most widely used and accepted within the Air Force at the time this study was accomplished.

Assumptions

Two assumptions form the underlying foundation upon which this study is built. The first is that the concepts of information processing (which includes Management Information Systems, Decision Support Systems, and Expert Systems) can be applied to and accepted by project management within AFSC. The second is that all AFSC organizations use personal computers that are compatible with the Zenith-248 systems listed on the Air Force Small Computer Contract.

Definition of Terms

The following key terms are used frequently throughout this study. They are defined as follows:

Application Software - Computer programs which accomplish user requirements. They can be general-purpose, commercial, public domain, vendor-supplied, or they can be programs specifically developed to solve unique problems. Examples include word processors, data base management systems, and spreadsheets (7:6).

Data - By itself, data is meaningless. It is facts (such as measurements or statistics) used as a basis for reasoning, discussion, or calculation. It must be changed into a useable form and placed in context to have value (32:35).

Decision Support Systems - Computer-based systems designed to organize or transform data into information. This is accomplished by presenting the information to the manager in a format suitable to aid in decision making (21:4).

Expanded Memory - Memory that can be accessed by specially-modified software in order to overcome the DOS-imposed 640K memory address limit for program data. The specifications for it were developed as a joint project by Lotus, Intel, and Microsoft. Hence, it is also called LIM memory. Expanded memory is more common than extended (or AT) memory, which it is commonly confused with (29:63).

Expert Systems - A special class of Decision Support Systems that stores facts and rules to mimic the decision process of a human expert. These systems also deal with situations characterized by a great deal of uncertainty, requiring a combination of experience and judgement to make a decision (32:16).

Extended Memory - Memory from the 1 to 16 megabyte memory address. This area can be use by IBM AT compatible machines to store data and programs. DOS does not recognize this memory space, but certain programs can use it. The specifications for this memory differ from expanded memory; therefore, the more popular LIM software does not recognize extended memory (29:63).

Information - Knowledge based on data that has, through processing, been given meaning, usefulness, and purpose. Data becomes information when it is transformed to communicate meaning, knowledge, ideas or conclusions (32:35).

Implementation - The process of preparing an organization for change, and then instituting the change by whatever means are possible (6:593).

Management Information Systems - Any of the manual, semi-automated, or automated systems that provide managers with timely, high-quality information that reduces a managers uncertainty about a given subject (1:52).

Project Manager - One who manages an activity or series of activities that will change the current state of the system, and for which a great deal of uncertainty exists (1:4).

User - This term is generally dependent on the context in which it is used. Therefore, for this study, the project managers who will ultimately be utilizing the software are considered the users.

Summary

The preliminary research performed thus far indicates that the information needs of AFSC project managers are not being met by whatever means are currently in place. Since it is the primary function of project management software packages to organize, process, and report the types of information most desired by managers, the researcher concludes that a standard information processing system is required for project management use. This project management system must provide timely, useable information in an understandable manner. Further, it must be accepted by the user as a tool to aid in the decision-making process. Once one or more software packages are identified for AFSC project management use, an implementation strategy must be addressed. Proper implementation will not only evaluate procurement methods, but also possible training techniques. The proceeding chapters support the research involved in satisfying these concerns.

II. Literature Review

Overview

This review of the literature describes and summarizes what is already known about using computers to improve managerial efficiency and effectiveness. Its purpose is twofold. First, it examines the potential area of study. Second, it establishes a common knowledge base among readers in order to promote a better understanding of the study.

Justification of the Literature Search and Review

The introduction of computers into the world of management in the 1950s had far reaching effects on most areas of management and corporate control. Simultaneously, communication and information theory led to the integration of computers and communication systems (11:10). These newly defined "systems" were the forerunners of today's office automation, the primary purpose of which is providing access to more and better information.

Proper use of information is the root of managerial effectiveness (8:194). Therefore, it behooves managers to have a thorough understanding of the most helpful information processing tools. When properly applied, personal computer-based project management software is one of the most powerful tools available today for creating information from cumbersome data.

Scope of the Research Topic

The scope of this literature review is limited to middle-level corporate management and below, as well as their military counterparts within Air Force Systems Command (AFSC). The data for the review was gathered from the most recent information available through managerial periodicals, professional journals, and management texts.

Organization of the Literature Discussion

The discussion of the literature follows four steps. In the first section, the review discusses what information is and how it is useful to the manager. The second section addresses proper expectations for the new information system. Third, possible methods to overcome the inevitable resistance and hindrances to introducing a new computer system are examined. The final section then concludes the review with a primer on project management and the use of personal computers.

Information

Information is data that has been processed in some way so as to make it useful to the manager. Information must hold some value for the user and add to his or her knowledge of the subject; it must convey something previously unknown or unpredicted (31:153; 32:35). In other words, it adds to knowledge but must be relevant to the subject matter.

Information should not be confused with data. The word **data** is derived from the Latin verb **do, dare**, meaning "to give," and is most fittingly applied to the unstructured facts spewed forth by the computer (31:152). Data, then, are unstructured, unevaluated facts having little or no meaning.

On the other hand, information is data that has form, structure, or organization that enhances its usefulness (32:35). Derived from the Latin verb **informo, informare**, meaning to "give form to," the word **information** etymologically conveys a sense of organization where there once was none (31:152). What is information for one person may be only meaningless data for another. Therefore, the term "useless information" is actually a misnomer since all information must hold some inherent value for the user. "Useless data" would be a more appropriate term. Information, then, is most fittingly applied to all data that have been presented to the user in some organized, meaningful form. How this information can be more expediently acquired is the subject of the next section.

What to Expect from Office Automation

"Management's computer confusion is often the result of overly optimistic, short-term, and therefore unrealistic expectations from new office automation systems" (16:28). These expectations have been formulated through three myths, which are: instant gratification, no follow-on costs, and static and sufficient cost justification (16:28). Each of these myths are explored in order to understand how to counter the existing confusion.

No Instant Productivity Increase. The most destructive myth is that office automation produces immediate productivity gains. This inevitably leads to unmet expectations since short-term improvements tend not to live up to the original expectations. "Office automation should be treated as a long-term investment, like research and development programs" (16:28). As office automation implementation matures, business benefits will gradually accumulate and have a greater effect on the organization.

High Cost Post-Implementation Support. The second office automation myth is that the user will require minimum training and support; all that needs to be done is purchase the system. This holds true for certain investments in which the purchase price of the equipment itself is several times the cost of installing and bringing it up (e.g., heavy machines) (16:29). Such equipment is installed once, its operators are trained, and it is used more or less in the

same manner and for the same purposes until it is replaced. However, the cost of office automation support, training, and installation should be many times the cost of the hardware and software (18:38). How these systems are used changes considerably over time. In fact, "uses must change for a company to fully profit from its investment" (16:30). A learning curve is usually encountered in office automation training and must be accounted for before a machine is purchased. Productivity may not increase immediately, but from a long-term perspective it will be greatly enhanced (18:38).

Nontraditional Cost Justification. The third myth in implementing office automation is that cost justification is final and that the systems are no-risk, no-lose productivity enhancements. Cost justification is a continuing process; however, its standards change over time as the office automation system and application mature (16:31). There is a strong tendency to employ traditional cost-justification techniques during the planning of an office automation system. These methods allow the technology to be used only on those applications where hard dollar savings can be realized (2:17). This approach argues for a highly specialized system serving a narrowly defined user group composed of individuals whose output lends itself to measurement -- usually clerical workers and secretarial personnel. Today's information-intensive organization,

however, is served better by a more general system encompassing a wide variety of generic tools that are accessible to many people at all levels of the company (e.g., a complete project management system) (2:17). However, because information worker productivity is difficult to define, let alone measure, the use of traditional cost-justification methods for office automation systems continues to exclude professional workers and middle-level managers (2:17).

If proper expectations are maintained, employees will be more likely to accept the new information systems. When unrealistic expectations are harbored, it is easy for new users to quickly become dissatisfied. These people will be the first to circumvent the new system, thereby causing deterioration in its overall effectiveness. The next section examines other possible causes of resistance to new information systems.

Avoiding Common Automation Pitfalls

Stephen Roach of Morgan Stanley, a New York City firm, claims that since the 1960s, aggregate information worker productivity has not gone up in this country, despite the billions of dollars spent on office information systems (2:17). Other researchers have also found little correlation between data processing expenditures and productivity. While some well run organizations do benefit from information systems, the poorly run ones often experience declines in productivity as data processing expenditures increase (2:17). These poorly run organizations have shaken the confidence of many managers and corporate leaders who are or were considering office automation programs. Many companies have failed to realize benefits from their office automation systems because of the inadequate planning concerning the selection of information systems. This portion of the review details the steps necessary to avoid the most common problem areas.

Recognize Normal Fear of Change. When an office converts from a manual to a computer-based system, or even from an outdated computer system to a newer one, there is usually some turmoil to be expected. Work is an important element in people's lives, and any change to the status quo tends to cause apprehension (3:78). Couple this human feeling with unfamiliar technology and there is the potential for disruption.

There are many possible sources for this resistance to computerization, and it is these differing viewpoints that make the resistance difficult to deal with (3:78). Managers see the computer as a boon to efficiency and productivity, while the people whose jobs are affected by its introduction (which could include the managers) may have a different view.

Change often threatens one's self-esteem or image in the eyes of others, as well as the survival instinct. Some workers may already have low self-images, and a confrontation with computers could confirm their worst fears of incompetence. This is especially true of people who believe they are not technically-oriented, and who may perceive the computer as their replacement (3:78).

At the management level, computer systems may upset the power structure or influence established procedures. For example, many computerized information systems allow top management to access information without asking lower management to collect and analyze it. As a result, lower management feels threatened, and may respond by slowing down the information flow or creating false information (3:80). This, of course, defeats the purpose of most management information systems, which is furnishing timely, accurate information (3:80).

The employee responses mentioned so far are predictable; therefore, the organization should be prepared in advance to handle them. Although methods for gaining acceptance of a

new computer system are relatively simple, they require special effort and attention by management (3:80). However, it is imperative that managers have the support of top-level management in demonstrating the efficiencies of computerization (3:80). If they do not have this top-down support, then any proposed changes could be circumvented by individual complaints up the chain-of-command. The following paragraphs delineate areas which managers should consider in order to avoid possible problems when introducing computerization to the office.

The Managers Must Set the Example. First, to reduce resistance, the managers must become computer literate and overcome personal fears concerning the machine (3:80). Sharing any fears experienced in learning about computers helps other anxious staff members to laugh at their own fears, making it unnecessary for the employees and staff to work through the fear themselves. The decision-maker should introduce the machine into his own office routine first and share the experience with the other staff members.

Advocate and Reward Computer Curiosity. This leads to the third step -- encourage and reward computer curiosity. There are many ways to stimulate interest in the computer. One way is to buy a system with a few software programs, including some games, and allow it to be taken home (3:80). This informal lender program provides an excellent starting point for managers who fear looking silly or fear performance

pressure. Even in computer-literate firms, there is a need for beginners to experiment off the job without additional pressures (3:80).

Encourage Employee Participation in Acquisition. A fourth way to ease resistance is to allow employees to participate in the acquisition process. Poor performance of a system can usually be linked to poor choice in vendors, systems, and implementation methods. Users have been given poorly integrated tools that are difficult to use or are of limited functionality (2:18). The worst case of this is where word-processing is done on one computer, databases maintained on a second, and electronic messaging performed on a third. Giving employees a say in the proposed use of a new system will ease its implementation and improve its chances of acceptance.

Employees should not have a choice about using the new technology; however, they should contribute to how the technology is introduced (3:130). This does not mean allowing them to choose the system. It means fully informing them about the systems under consideration and inviting them to submit suggestions that would aid in choosing the system and easing the implementation.

Examine Both the System and the Mission. The fifth issue relates to what work is done by an organization, how that work is scheduled, and how the organization is structured to accomplish its mission. Too often, existing

procedures are simply transferred "as is" to an electronic environment with little consideration of how the new office automation tools might allow things to be done differently or more effectively (2:18). In choosing a system, one usually asks, "What do we do," when the question should be "What do we need to do." Computers do not inherently add value to a process, they only speed it up. And, if a function has little or no value to begin with, simply increasing the speed at which it is performed will not translate into benefits.

No Indiscriminate Use of the Microcomputer. Another significant contributor to office automation failure, along the same lines as the previous area, is the indiscriminate use of the microcomputer. For the user, a microcomputer on the desk offers self-sufficiency, control, and independence.

> While the microcomputer may seem to be a good solution to the problem of data management, it is more just an expedient one. Microcomputers are easy to acquire and easy to install. The proliferation of these "islands of information" may provide some limited benefit for the individual user; but, from a larger perspective, it suboptimizes the investment as a whole, as users begin expending time in an uncontrolled environment developing redundant systems and applications. [2:18]

The microcomputer is a marvelous tool, well suited to many circumstances and applications. However, in areas where the productivity of a group is paramount, or where there is a need to share data among many people, it is not generally the optimal solution (2:19). The discussion will now conclude with an examination of training for the newly acquire office information system.

Proper Training. A last point in easing resistance is to provide thorough training (3:130; 18:38). Although the number of computer-leery professionals has diminished, many executives remain fearful and uncertain where computers are concerned (18:38). This uncertainty is often well-founded, since learning to use a computer is never as easy as the computer vendors proclaim, nor are computers as user-friendly as purchasers would like them to be. A change of work is threatening, but thorough training helps to alleviate the threat. This should involve more than just handing someone an instruction manual.

Currently, most of the training performed for new systems is keyboard training that teaches users the features and functions of the personal computers or software. However, users also need to be taught the appropriate uses of information and the dangers of misuse (17:37).

Data literacy education should deal with how a company acquires data, and the contents and meanings of the data, as well as its translation into information (17:38). The education should also seek to de-emphasize the mystique of numbers, which can become overly important because of the myriad of ways computers can present them (17:38).

Easy access to data can blur the distinction between useful analysis and flowery reports that are generated simply because it can be done. Reports can be generated that look good but are erroneous or misleading. "Too often, these

(erroneous) reports are assumed to be accurate and are used to make business decisions" (17:37).

Follow-up training is essential to achieve maximum productivity from a computer system. A three to six-month follow-up program to initial training is thus advisable (3:130). While initial training tends to be technical in nature, it should also focus on understanding the system's rationale, including how the parts fit together, and how it can increase individual and group productivity (3:130).

Computers have become the new media, and even if a manager does not plan on using them it is almost certain that an employee will (27:17). Data processing, word processing, computer literacy, and systems management are examples of the new needs that are tied into computers. The training for these applications should be presented in a structured, individualized approach (27:17).

Having developed a proper understanding of the benefits to be derived from information systems, and having examined ways to breakdown the barriers encountered when implementing a computer-based information system, the discussion now turns to use of the new information system in the project management environment.

Project Management

Project management is a way of imposing structure on a complex intertwining of time, resources, and activities. It requires a panoramic eye, logical thinking, a measure of statistical dexterity, a feel for detail, and a willingness to bow to circumstance (1:25; 12:14). Using a personal computer will help in these areas, but only if the user has a thorough understanding of the methodology of project management. Project management is a way of thinking about problems, and could be applicable in one form or another any time there is a onetime task that requires: 1) the efforts of more than one person, 2) the allocation of scarce resources, and 3) the resolutions of many as yet unknown problems and requirements (1:7; 8:10; 10:8; 12:2-5; 19:2-3; 20:7). These constraints exist because most conflicts can logically be resolved if they are small enough. However, when two or more individuals must share resources under uncertain conditions, the possible outcomes and repercussions are generally more than the human mind can assimilate. These are the circumstances where a tool to organize and process information becomes most useful.

Use of Computers. In the early 1960s, when critical path scheduling was introduced, mainframe computers took a great deal of time, well over a week, to come up with a meaningful set of output that could be used by management and reproduced for hard copy distribution (34:1305). As hardware

and software problems have been solved and as the costs of computing have been reduced, use of the computer in project management has spread into smaller projects (12:164). The reasons are straightforward. The microcomputer is making rapid access to large data sources a relatively easy process; and at the same time, the costs of providing this access are being reduced dramatically (13:29; 34:1305).

Project managers in particular must analyze large amounts of data on a daily basis. Thus the modern project manager has a critical need for skill in microcomputer use to increase the effectiveness, efficiency, and accuracy of decisions made. Louis Goodman describes why project managers have an extraordinary need for information:

> ... project managers require as much information support as any other manager -- more so, in fact, because: 1) the information needs usually have to be filled faster and under greater time pressure, 2) the innovative nature of the project requires information in a different form, or from a different group of people, or with a greater degree of complexity and sophistication, and 3) inadequate information makes the risks already inherent in project management much larger. [13:29]

It is apparent that the introduction of the microcomputer is likely to dramatically change the nature of the project manager's work (1:124; 12:164). Computers and programs now make the various techniques for managing a project more directly accessible to project managers, making it possible to analyze a problem, speed up the process of decision-making, and thus cut costs in many areas (13:29; 14:574).

The Five Elements Of Management. The realm of management can be broadly divided into five elements. All elements are generally present in the management of any undertaking, although their complexity varies depending on the size or scope of the unit managed. They are especially apropos to the complex, narrower spectrum of project management. The five components are: planning, organizing, staffing, directing, and controlling (1:15,31,49; 13:22-28; 24:2; 31:273). However, the all-encompassing requirement necessary for success in any of the elements is decision-making (8:192-193; 20:241). A manager is first and foremost a decision-maker. As Peter Drucker states, "A decision is a judgement. It is a choice between alternatives. It is rarely a choice between right and wrong" (9:470). The five elements of management are examined in the following paragraphs from a project management perspective. Additionally, important features and terms of project management software are shown in boldface and discussed.

Planning. Planning should be the most lengthy, time-consuming, and tedious portion of the project management process (13:22). If adequate time is spent "up front" planning the project, many problems can be avoided in later stages. Although planning is the first phase of project management, it actually starts with the project's end -- the objective. One must know what needs to be achieved before it is possible to determine the proper methodology or costs.

With the objective in mind, the manager then plans the **Activities** or **Tasks** that will lead to successful completion. If, for example, the objective is to have a house built, typical activities might be "select location," "choose style," and "hire contractor." As activities are added to the list, so is detail. Therefore, "choose style" may be composed of "conduct needs analysis" and "research different styles." These tasks will, in turn, be composed of others. Before long, a sense of project flow develops. Logic will dictate which activities must follow each other and which ones can occur simultaneously.

Outlining, which has recently become part of the best programs, is a very good way to do the list-making part of planning. One may also use other, more traditional project management techniques in conjunction with outlining. One of these traditional approaches is the **Network Diagram** (1:3; 20:663-665). This is a graphic representation of an outline, and there are two ways to draw it: the arrow diagraming method (ADM) and the precedence diagraming method (PDM). In an arrow diagram, activities are represented by arrows placed between a start circle and an end circle. The circles are points in time and have no duration associated with them. In a precedence diagram, tasks are represented by boxes, which are connected by arrows showing the project flow. PDM is the more popular of the two methods and is used by the majority of project management software systems.

Organizing. Organizing is an extension of the planning process. It involves evaluating all human and nonhuman factors that could come to bear on the project (13:23). The network diagram gives a skeletal breakdown of activities, and the organizing phase now gives it some flesh, while keeping factors such as time, personnel, and dollars in mind.

While the network diagrams of the planning phase illustrate the general movement of a project, they are missing a crucial element -- time (19:320). The **Gantt Chart** takes this element into account. The Gantt is a horizontal bar chart laid down under a date line scaled in any time unit desired. Activities are listed down the rows on the left side of the chart, and the bars representing them are sized to show their expected duration. The order of the bars from top to bottom gives one some of the same sequential information as the network diagram; however, the Gantt chart also shows start and end dates for every activity and for the project as a whole. A sense of precedence is derived from the cascading effect observed in the placement of activity durations. See Appendix C for an example of a Gantt chart.

Dependency Constraints ordain the relationships between tasks. For example, some tasks cannot begin until others are completed due to physical or logical laws. If a new wall in a house is being erected, then the framing must be done before the wallboard can be put up. This is a physical

constraint. Task relationships with this pattern are said to have a **finish-to-start** dependency. There are several other dependency types: **finish-to-finish**, **start-to-start**, and **start-to-finish**.

Each task can have a number of dependencies at once, making the relationships in a project schedule very complex. To see which tasks are crucial to the on-time completion of the project, a process known as the **Critical Path Method (CPM)** is used (1:3-4; 19:334). To figure out the critical path, a personal computer-based project management program determines the earliest and latest possible start and finish dates of tasks, factoring in their dependencies, durations, and the start date of the project. The critical path tasks are those whose early and late dates are exactly the same. In other words, they must start and finish precisely on time, because a delay in any one will delay the whole project.

Another planning technique, the **Program Evaluation and Review Technique (PERT)**, is often used as a synonym for CPM or for network diagraming (12:169-170). However, it is a very distinct and specialized technique for dealing with uncertainty in task duration (19:334-337). When one uses PERT, every task is given an optimistic, pessimistic, and most-likely duration. The varying durations are analyzed through probability equations to derive the most likely task duration (1:3-4). This technique is excellent for project or activity duration risk assessments (19:335).

Staffing. After the critical path has been determined, one may now commit **Resources** to each activity. A project's resources usually include any or all of these six items: money, manpower, equipment, facilities, materials, and information (20:4). Details about their quantity and cost are entered into the computer on task or resource screens, while information on daily and hourly availability is entered on **Resource Calendars.** Resources can have a tremendous impact on the schedule. If, for example, a task would normally take three days to complete, but the resources can be applied for only four hours a day, the task will take six days.

Typically, once resources are assigned to specific tasks, one will discover that some are over-allocated. This can be seen most clearly by looking at **Resource Histograms.** A histogram is a vertical bar chart of resource capacity. If a resource is assigned full time to two tasks during the same period, the bar will top the maximum line on the chart.

There are two approaches to correcting resource conflicts: 1) adjust the resource availability, or 2) delay tasks, which may delay the project. Most project management programs will automatically reschedule tasks with conflicts through an approach known as **Automatic Resource Leveling** (12:190-191). In one type of resource leveling, only available float time is used to change activity dates (i.e., only those tasks not on the critical path are rescheduled).

However, this is often an insufficient answer to the problem. The second kind of resource leveling actually delays even critical tasks, thereby delaying the whole project, until no resources are over-utilized.

When the resources are finally assigned, the critical path set, and the costs entered, one has a complete project plan. This plan is often referred to as the **Baseline**. It is saved and used as the standard against which the progress of the project is measured.

Directing. This area is, in a sense, the core of management, since it deals with the day-to-day responsibilities for seeing that available resources are being channeled to meet the task objectives efficiently and effectively (13:27). Having generated a baseline, the actual start dates, resource time spent, percentage of task completion, and costs will now be entered as often as needed in order to track the progress of the project. The tools for this part of project management are **Actual-versus-Baseline** Gantt charts and **Progress Reports**. As always, it is the responsibility of the project manager, not the computer system, to analyze the current status of the project and determine where change is necessary. The project management system is merely a tool to aid in the communication and analysis of information.

Controlling. This is the process of making events conform to plans (13:27). Here, ongoing monitoring is performed to ensure that objectives are met and activities are moving along well. Controlling tends to have a long-term focus, while directing is more day-to-day. A properly implemented computer-based project management system will act as an effective control system, allowing the manager to quickly analyze alternatives and diagnose potential problems (13:29).

Progress reports will be a primary tool used in controlling projects. One can quickly tell where fault lies if the reports are generated accurately. One of the most important reports is the Earned Value report. Earned value does numerically what graphical approaches, such as Gantt, do through charts. It can actually be calculated in a variety of ways, but it is essentially a measure of the impact of cost on a task in progress when it is compared with the baseline. For example, if only 25 percent of a task's objectives are achieved halfway through it, and the baseline cost of the task was $100,000, then the task has an earned value of $25,000. Earned value reporting is required in all major government defense contracts (12:200).

The other reports generated during the controlling phase will serve as summaries of progress for upper management, or detailed blueprints of tasks and resources for lower-level managers. The reports will also indicate problems that are

the result of unforeseen circumstances. This will send the project manager back to the planning activities in an attempt to alleviate problems, thus closing the five phase process with a feedback loop. The planning process is highly iterative and should continue throughout the life of the project.

Project Management Summary. It is important to note that the software being discussed is one tool available to the project manager. It is possible that none of these automatic techniques may yield an optimum schedule. The manager may have to manually readjust resource availability, move tasks around, or even rethink the way an activity is accomplished. The computer performs the complex calculations, freeing the manager to think and evaluate different alternatives. The computer is a decision-making aide, not a decision-maker.

Project management is difficult and time-consuming. It forces the manager to think through a complex process and then record detailed, actual data. Managers should adhere to the methodology of planning, organizing, staffing, directing, and controlling, and use a personal computer-based project management system for all the computational, graphic, and reporting support it can supply. Highly skilled project managers will promote a more timely acquisition of lower cost defense systems.

Summary of the Literature

This chapter has presented a structured walk-through of the elements necessary to more effectively utilize a personal computer-based project management system. It started with a discussion of information, which noted that information is data that has been presented to the user in some organized, meaningful form. Proper expectations for information systems were then presented by exposing three common myths of information systems, and stressing that there is: 1) no instant productivity increase; 2) a high cost for post-implementation support; and 3) risk involved in implementation. Several ways of avoiding the most common pitfalls of automation were then discussed. The discussion then ended with an overview of project management which outlined the general elements and listed several areas where project management software systems should be used.

A project whose team spends a good deal of time developing a thoughtful qualitative plan that team members agree is viable has a higher likelihood of success than a project where plans are developed by one or two people working alone with a sophisticated computer-based project management system (12:221). The combination of strong commitment and good tools is the best possible situation, reducing dramatically the likelihood of project failure caused by planning and control deficiencies (12:221).

Computer-based information systems, when properly implemented, enable information technology to create competitive advantages by improving information flow. However, no amount of computing can replace an astute business professional who examines raw data and says, "This doesn't look quite right" (17:38).

III. Methodology

Overview

This chapter describes the steps that were taken to accomplish the research objective and answer the investigative questions posed in Chapter I. The specific methodology used is stated and justified, with particular attention paid to confirming the validity of the approach.

Research Procedure

The review of the literature has shown that a gap exists in the information processing needs and abilities of AFSC project managers (15:3; 23:3). Research has shown this gap to be caused by faulty selection of software, as well as inadequate training (3:130; 15:2; 17:37; 23:3; 33:1). Since this study is focusing on AFSC project managers, the software that would be most beneficial to them would be a comprehensive project management package. These systems aid in schedule generation, resource management, and cost analyses, the three areas that comprise most of a project managers day-to-day work (13:28; 19:329-334). Therefore, the existing state-of-the-art project management software packages that are available either commercially or through government contracts were evaluated to determine which ones best meet the needs of AFSC project managers.

Methodology Justification

The final outcome of this study will be a recommendation as to which project management system is best for AFSC project managers. However, this recommendation in and of itself will have little lasting value since project management software is continually being changed, refined, and upgraded. Therefore, it is the primary intent of this study to produce a systematic approach that can be used to evaluate new software releases and versions as they occur in the future. The actual recommendation is of considerable importance at the time this research was accomplished; however, it is of secondary importance to the overall study.

Breakdown of the Study. Solving this research problem required data gathering and analysis. The data analysis primarily involved a comparison of how well the different software products met the needs of AFSC project managers. The following three-phase approach was chosen to ensure a rigorous, accurate, and useful coverage of the topic. The phases are: 1) a literature review to ensure thorough understanding of existing, pertinent research as well as establish a common knowledge-base for readers, 2) information gathering on the available project management software packages and manufacturers, and, 3) evaluation, comparison, and analysis of the gathered data.

Although the overall effort is divided into these three phases, each one can and should be conducted independent of the others. However, the information generated by each phase is imperative to the successful completion of the subsequent phases. Therefore, although each phase need not be completed before the start of the next one, the previous phase should be well underway.

Validity Concerns. As with all scientific research, validity is a primary concern. Validity can be broken down into two types -- internal and external. A high degree of internal validity results from the researcher accurately and thoroughly measuring what is intended (5). In this analysis, internal validity is directly proportional to two areas: 1) the completeness of coverage of all the existing project management software, and 2) the lack of bias in the comparisons of the different packages.

Internal Validity. The researcher has striven to maintain as high a degree of internal validity as possible by continuously re-examining the two areas noted. Completeness of coverage was ensured by examining the project management periodicals. From these, most of the systems that invested heavily in advertising were identified. Marketing representatives from five of the manufacturers of the more expensive software products were contacted in an effort to obtain a list of their competitors in the project management arena. Since the Department of the Air Force was conducting

this study, most of the vendors were extremely helpful in providing the desired information. Almost identical lists of rival companies and software products were obtained. The study assumed that the vendors fully disclosed information on their competition. Since the data from the five companies matched well, and since no other project management software packages were listed in the literature reviewed, this assumption is objectively defensible and the project management software market was thoroughly covered. Appendix A contains the list of all known project management software packages and their vendors; the packages are listed in alphabetical order according to the manufacturer's name and are indexed for ease of reference.

In handling the second point, reduction of bias, the researcher employed the use of a panel of experts. This technique, as well as the composition of the panel, was mutually agreed upon by the researcher and the thesis advisor. The panel was comprised of ten individuals having considerable computer and program management experience, and representing a broad spectrum of potential users of the project management systems. The upper levels of management are represented by a deputy SPO director and a directorate chief. Moving down a level on the management hierarchy, there are two each of both program managers and computer engineers. In order to incorporate the view of personnel outside the acquisition field, two AFIT instructors were

used, as well as two small computer specialists. Having established the desired composition, the researcher then hand-picked individuals who would willingly support this study. Appendix B contains the list of expert panel members and their specialties.

Proper and thorough definition of the evaluation criteria are the keys to bias reduction during the evaluation. The following theorem is of primary importance: "Any criterion not considered will not be included in the choice of the optimal system" (25:80). This states explicitly what should intuitively be avoided. All criteria must be defined up-front and agreed to as valid. Then, during the evaluation, only those criteria listed are evaluated. This inhibits personal biases from examining extraneous areas, and promotes an evaluation based purely on predefined needs.

Each member of the panel was tasked to review the criteria used to evaluate the software packages, as well as the relative weights associated with each criterion. This improved internal validity by reducing any biases resulting from poor criteria selection and definition. All of the responses were gathered and analyzed. If any criteria needed to be added, each member of the panel was asked for his/her opinion of the importance of the proposed criteria. Once a firm list of criteria was developed, the relative weights were examined. Again, all members were asked to provide

their expert opinion on the optimal weighting. If there were extreme variations in the recommended weightings, each expert's opinion was sought for the specific instance. The recommended weights for a single criterion were averaged once they were all in a reasonable range, and the average weight was then assigned to the criterion.

External Validity. External validity involves the applicability of the study to areas outside the intended audience, and is of secondary importance to internal validity (5). Since this thesis is aimed at improving information flow for AFSC project managers, generalization to anyone outside of that target group may not be possible because the study was not designed for them. It is believed that project managers within both the Department of Defense and civilian industry could benefit from the results of this study; however, the study must be expanded outside of AFSC to verify this. Therefore, the external validity cannot be confirmed at this time.

Research Methodology

A three phase approach was used to examine the research objective and answer the resulting investigative questions. Each phase is detailed below.

Phase I - Literature Review. A literature review was conducted to identify possible problem areas that prevent project managers from using computers more in everyday managerial tasks. Details were also gathered on what information project managers deem most important but least available. The possible ways of overcoming the inevitable resistance to both change and computers was then examined, as well as areas of concern for training on the new systems.

Phase II - Information Gathering. The second phase involved gathering specific information on all the current project management software packages. This was an ongoing effort, continuing throughout all phases of the evaluation. It was by far the most time-consuming task, since internal validity rides on complete coverage of the software market. Any organization that hopes to get the most up-to-date functionality out of project management software, thereby increasing project management productivity, must continually monitor this rapidly changing market.

The study was focused on project management software for use by AFSC project and program managers. Therefore, the software of interest was targeted for operation on the Zenith-248 personal computer systems. These IBM AT

compatible systems are the most widely used personal computer systems within AFSC at the time of this study. Only software packages that met the following initial constraints were considered: 1) the software must run on IBM AT compatible machines running a DOS operating system, and 2) the software must run on low-density (i.e., 360 kilobytes, or 360K) floppy disk drives. Both of these constraints are driven by the target computer system.

Phase III - Data Evaluation. The third phase involved an evaluation of all the previously gathered project management software data. Capt Dexter Handy's thesis, entitled "A Requirements Analysis Model For Selection Of Personal Computer (PC) Software In Air Force Organizations" (14), served as a framework for the comparison effort. Subsequently, the evaluations that were performed on each package were moulded around the needs determined in Capt Handy's thesis. Those needs are stated below:

> However, users did find requirements for software based on the need to accomplish six knowledge work tasks, and four qualitative factors. The knowledge work tasks included authoring and presentation, planning and decision support, monitoring and control, organizing and scheduling, diagnosis and problem finding, and communication. The qualitative factors included interoperability and transportability of data between PCs, mainframes and other software types and products, evaluation through demonstrations or periodicals, cost considerations, and other factors such as downwardly mandated software product purchases. [15:47]

Each of the critical areas stated on the previous quotation served as a category for comparison of the different software products. The areas were combined where it made sense to do so, and a list of evaluation criteria was developed. A structured evaluation approach was generated in order to perform the actual comparison of each of the project management software packages. The approach for Phase III involved four stages, each of which are discussed below.

Evaluation Philosophy. The information gathering phase (Phase II) is an all-encompassing area that completely surrounds this four-part evaluation. It is not necessary to have all information gathered before the evaluation can begin. As new versions of the software and new products enter the market, only the new entries need to be evaluated. Their "score" can then be compared to the other existing products or versions. All previous systems do not have to be re-evaluated against the new entry. This allows the Air Force to quickly keep up-to-date on what project management systems will best meet their needs.

This entire study is fighting two opposing forces: 1) the software manufacturer who is trying to force the system into a user's hands, and 2) the Air Force project manager who has already had several project management systems thrust upon him. A project manager cannot be forced to use project management software (as depicted by the Literature Review -- Chapter II). However, the proposed system must be functional

functional as well as friendly and aesthetically pleasing to the user. If not, it will fall by the wayside as did other major project management systems (i.e., SYSNAS and AMIS).

The evaluation is analogous to using four sieves. The software packages must pass through four "sieves" to get to the end. Each sieve has an increasingly finer mesh to separate the "coarser packages" from the "finer ones." All of the software packages that pass a given stage (or "sieve") progress to the next stage, where another evaluation is performed independent of all previous ones.

Stage 1 - Preliminary Information Review. The first stage of the process is designed to "weed out" the irrelevant systems from consideration. The focus in this section is to determine which manufacturers produce project management software that runs on the computer systems of interest. At the time of this writing, the most widely used personal computer in Air Force program offices was the Zenith-248 Personal Computer.

There are several areas which must be examined in order for a candidate project management software package to pass to the next stage. Those areas are listed in the following paragraphs and are worded as they were used for this study. The wording can be changed to accommodate the technical specifications of any computer system.

Memory Constraints. Since the information gathering phase allowed only software that runs on the target computer system to be considered, one knows that the all the software runs on IBM AT compatibles. However, some software requires more Random Access Memory (RAM) than is available. For this review, only systems that could operate at 640K, which is the maximum main memory addressed by the MS-DOS operating system, were considered.

Some Zenith-248 systems have an optional 512K of Extended (or AT) Memory which was popular a few years ago. However, most of the recent project management software does not recognize this memory. Some do require Expanded Memory

use, which would require the purchase of a new printed circuit board and memory chips. Therefore, only those packages capable of running with 640K of main memory were considered.

Additional Software Requirements. Some software requires the use of Microsoft Windows or Lotus 1-2-3. This software was not considered because of the additional burden of learning another software package, as well as the added expense.

Additional Hardware Requirements. As in the previous case, some software requires the use of a mouse, joystick, or plotter in order to attain all of its functionality. Other software requires a math co-processor to handle complex schedule, cost, and resource calculations. This evaluation considers only stand-alone project management software packages. Therefore, if additional hardware was required to operate the software, the project management system was not considered.

Cost. An examination of Appendix A shows that the price range for the software packages being considered varies between $49 and $9,995. These prices include plotter graphics options (if available) in order to accurately compare systems with plotter graphics as an option and those with it built-in. The highest priced packages represent the extreme high-end of project management and are designed to handle very large, mega-projects. This type of project is

outside of the scope of this study. Therefore, the research was focused on those packages that cost less than $3000. This cutoff price was agreed upon by the expert panel for two reasons. First, it is at a natural break point in the data (i.e., there are no software packages that cost $3000 to $3999). Second, it represents the assumed highest price that the typical AFSC organization will be willing to pay for one of these project management systems. Therefore, any software packages with a price of over $3000 was considered cost-prohibitive and dropped from further consideration.

Stage 2 - Demo System Review. The second stage of the evaluation is designed to highlight the systems that do not perform the primary project management functions and would not be easy or desireable to use. In this stage, the demonstration diskettes provided by the manufacturers are examined. If no demo disks are available, then printed technical information and output demonstrating the various activities that can be performed are examined. If nothing is available for review, then the vendors were contacted by telephone and asked to respond to the criteria. If they did not admit to being deficient in any area, then the software was allowed to default to the next stage -- Stage 3. Admittedly, the vendors could bias their answers, but that would only cause their systems to fail at a latter stage. The questions in each area below must be answered in the affirmative in order for the software package under consideration to pass this stage of the evaluation.

Primary Functionality. Does the system provide the primary functionality required by all non-trivial use of project management systems? The capability must exist to handle these three areas: schedule development, resource allocation, and cost analysis.

Graphics. Is the system graphics based? This ensures that activities and dependencies can be depicted graphically, thereby prohibiting software that exclusively uses textual listings. The old saying that a picture is worth a thousand words is very true in the presentation of information.

Information Presentation. Does the software use a good mix of colors and differing screen types to keep the user's attention and highlight areas currently being examined or changed? A soothing screen display and color mixture will make the software less of a chore for managers to use. Also, do the screens present a useable amount of information? Too much information could overwhelm the users, while too little could force them to change screens excessively and become frustrated.

Stage 3 - Minor Project. The evaluation now turns to actual use of the systems that make it to this stage. This is the first time that the candidate systems are actually operated. Individually, each system is installed on the computer system desired, and a small project (containing approximately 50 activities) is entered. If a tutorial is available, it is examined in this phase prior to entering data. Once a fundamental working knowledge of the system has been established, the user then enters the benchmark minor project outlined in Appendix C. This benchmark project is the actual project breakdown that was used to accomplish this research study.

As was the case in the previous stages, there are several areas that must be passed before the software being considered can move on to the final evaluation stage. Those areas are outlined in the following paragraphs.

Installation. Can the system be installed quickly and easily without a thorough knowledge of the DOS operating system? Is the documentation clear and well-written?

Tutorial. Does a tutorial exist? Is it helpful? Can it be used by both novices and experienced project managers?

Data Entry. Can activities be entered in a variety of ways? Since the final software system will be recommended for used by many different people, it must be

able to be manipulated different ways. Can the various project management data be entered quickly and easily? Examples of such data are dependencies between various tasks, cost data, and resource information. Some high-end software packages are difficult to use because of the tremendous amount of functionality and flexibility.

Reporting. Can a report be produced on the screen and sent to a printer?

It is important to emphasize the point that in this stage, all of the previous questions are answered through actual use of the system. It is not enough for the system to be capable of the performing the above functions, they must be easily learned and performed. That is the main point of this stage -- to emphasize which software packages allow the user to become productive quickly. A new user should be able to feel comfortable on a new system relatively quickly, while learning all the functionality could take months. It is the researcher's opinion that a good "feel" for a new system should be able to be developed within one hour, although this was in no way used as a test criterion.

Stage 4 - Major Project. This is the major and most time-consuming stage of the evaluation. It involves using the candidate software packages to plan, track, and report on a benchmark government defense contract. This phase is not designed to thoroughly examine the limitations of each software package (i.e., can it handle 5000 activities and 3000 resources, each with their own separate calendar?), rather, it is designed to test the software packages by using them in the same way that they will be used by Air Force managers -- with a full-fledged government defense contract. Appendix D contains an overview of the project used, as well as a list of the activities involved and pertinent reports.

The criteria that are used to evaluate the packages in this stage are extensive and often require a subjective assessment. They are designed to discriminate between the best project management software packages on the market and determine which one (or ones) will best meet the needs of AFSC project management. The paragraphs that follow examine the criteria in detail by explaining each criterion and breaking them down into their most important elements. For the quantitative criteria, a grading scale or delineation is stated. Table 1 contains a list of the criteria and initial recommended weights for the fourth and final stage. The adjusted weights, based on the recommendations of the expert panel, are discussed in the expert panel analysis section of Chapter IV.

Table 1 - Stage 4 Evaluation Criteria and Weights

1.	Project Modeling Capability	8.0%
2.	Scheduling Capability	8.0%
3.	Resource Management	8.0%
4.	Cost Management	8.0%
5.	Tracking and Controlling Existing Projects	8.0%
6.	Reporting Capability	8.0%
7.	Advanced Project Management Functionality	8.0%
8.	Documentation	7.0%
9.	Ease of Learning	10.0%
10.	Ease of Use	10.0%
11.	Vendor	7.0%
12.	Cost	10.0%
		100.0%

Grading Scale. The grading scale that follows was used to assign a value to each criterion reviewed for the software packages. The sum of the grades given for each criterion will yield the score for each project management package. The scores for each package can then be compared, and the system that receives the highest score will be considered the optimal package for AFSC project management use. The scale is shown in Figure 1.

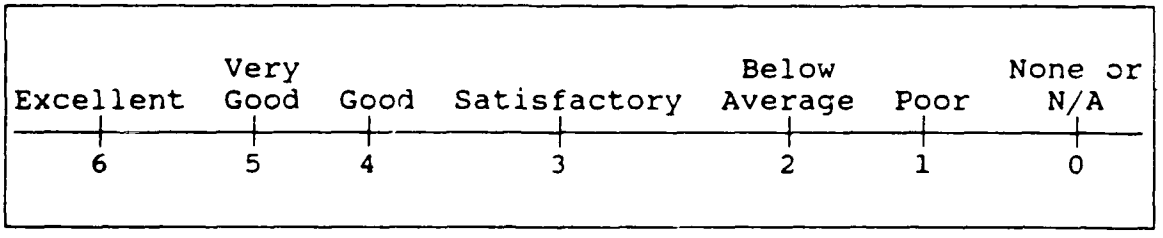

Figure 1 - Grading Scale

Criterion 1. Project Modeling Capability. This area is designed to evaluate how easily the initial plan can be created. Since planning is a highly iterative process, an initial plan may be rough and incomplete, but subsequent plans must be more detailed. A good project management software package allows for very easy entry of incomplete project data, as well as simple insertion of additional information and updating procedures. The following paragraphs contain the areas of concern.

Capacity of System. What is the number of activities allowed per project? The average number is approximately 1000. Also, are the number of resources allowed per activity or project constrained? The average is approximately 200. What about the number of dependencies allowed per activity (i.e., the number of activities that must either start or finish before another activity can start)? The average for this is approximately 10. If the software's capacity was only the average, it received a 3, while the packages that were constrained only by memory (in effect being unlimited) received a 6.

Extensiveness of Options or Features. Are the managers free to model projects in their own style, or are they forced into a pre-determined mould (i.e., does it support a structural breakdown of activities, such as an outline, as well as conventional diagramming techniques such as Activity-On-Arrow and Precedence)?

Criterion 2. Scheduling Capability. All projects differ in one way or another. Therefore, different schedules exist for different purposes. The optimal system should have the ability to present, produce, and manipulate scheduling information in a variety of ways.

Schedule Type. Does it support screen-interactive Gantt, PERT, and time-scaled network diagrams?

Scheduling Time Base. Are managers able to switch easily between hours, days, weeks, months, and years in order to examine various activities and resources?

Accessibility of Information. Are the project's logic (precedence notation), activity details, and project/resource calendars easily examined and modified?

Criterion 3. Resource Management.

Individuals obviously cannot contribute more than 100% of their time to a project, no matter how many activities they are responsible for. Additionally, a project may occasionally interrelate with other projects by sharing resources with them or in some way depending on them. Proper resource management enables the project manager to handle complex resource dependencies within and across organizational boundaries.

Planning. Is the system capable of handling individual resource calendars and cost information?

Leveling. Will the software automatically adjust the project schedule to compensate for availability of resources assigned to conflicting activities, or even those assigned to other projects (i.e., resource leveling)? Also, does it recommend how to contract the remaining activities in order to complete a potentially late project on-time (i.e., time leveling)? Does it permit individual resource leveling as well?

Tracking. Does the package easily identify whether or not resources are being used efficiently (i.e., no severe under- or over-utilization).

Criterion 4. Cost Management. A large portion of every project manager's time is spent determining the adequacy of funding. Required versus approved funding is examined, and projections continually updated based on the most recent information. A good software package should readily provide the basic cost analysis information normally desired by Air Force project managers.

Planning. Does it have the ability to establish a broad, loosely defined budget plan?

Programming. Can funds be broken down into different categories and assigned to various project areas?

Budgeting. Can specific amounts be assigned to various activities and milestones?

Tracking. Is the package capable of tracking project progress based on budget and to-date progress (i.e., earned value, and cost/schedule techniques)?

Criterion 5. Tracking and Controlling Existing Projects. Tracking involves comparing original planned information with the revised or actual data; it can be applied loosely or very rigorously (as it is in most government defense contracts). Timely tracking is used for control purposes and is crucial to all major projects.

Data Entry. Can the system quickly and flexibly post progress about actual time, cost, and resources expended.

Analysis. Does the software provide useful analyses of tracking information for controlling purposes (e.g., time leveling, where remaining activity durations are contracted in order to meet schedule deadline), or does it merely act as a notepad to record what has happened?

Criterion 6. Reporting Capability.

Periodically, the project manager reports to the project team, as well as senior management, on the status of the project and on the team's role in completing it. Therefore, project management software should provide clear, presentation-quality reports with varying levels of detail. Summary reports and good use of graphics are thus necessary for the five areas previously mentioned.

Customized Reports. Can report formats be changed? Can sorting be done in a variety of ways? Is there a high degree of selectivity (i.e., can reporting be done on just the items of interest)?

Quality of Output. Can all reports be viewed on the screen? Is the printed output of presentation quality? Does the package support plotter graphics?

Criterion 7. Advanced Project Management Functionality. Managers must try alternatives to truly understand a plan, obtain the optimum solution, meet project constraints, or respond to management questions. Consequently, project management software should be able to quickly present a solution on the basis of user-specified parameters. Speed and convenience are of the essence.

Baselining. Can the project act as a baseline while various analyses are performed on a test copy? Can the two be compared automatically, or is manual comparison required?

Analyses. Does the system have the ability to define hammocks (i.e., groups of activities reported on as a whole), conduct sophisticated "what if" analyses, perform risk assessments (e.g., true PERT), and analyze cost tradeoffs?

Interfacing with Other Programs and Computers. Can the system import and export various file formats (i.e., ASCII delimited, LOTUS 1-2-3, dBase, etc.)? Is it capable of being used over a Local Area Network (LAN)?

Criterion 8. Documentation. Quality documentation allows the user to reach the full potential offered by the software. It is an area often overlooked or given little importance. Good documentation will allow users to quickly and easily find answers to most questions concerning the operation of and theory behind the software.

Understandable. Is the documentation clear and well written? Is it understandable by non-technical personnel? Is it written to the proper level? Are the illustrations helpful? Are there enough illustrations?

Useable. Can the desired information be found quickly and easily? Are the documents thoroughly indexed?

Criterion 9. Ease of Learning. First impressions are lasting impressions. It is imperative that the system be easy to learn since people tend to get frustrated quickly with computers when they are used to change the status quo. The user must quickly be put into a positive frame-of-mind in order to use the system most effectively.

Hands-on Tutorial. What type of tutorial is provided? Hands-on type tend to be more effective since they encourage the user to "learn by doing".

Productivity. Is the manager able to become productive quickly on the software, or does the whole package have to be learned before it can be used correctly?

Criterion 10. Ease of Use. The human interface is a critical area of consideration. The more friendly and aesthetically pleasing the screen presentations are, the easier their use tends to be. The mechanics of normal operations must be examined in the same vein. If a project management program is going to be used by all kinds of people, then the friendlier the interface the better.

Screen Color Mix. Does the system have a well-designed color mix on the screens? Does it let you easily change the colors?

Program Hierarchy. Is the command structure logical (i.e., are the commands broken down into some type of input-processing-output format)? Do the normal operations flow? Are there an inordinate number of commands required to perform certain operations?

Command Presentations. Is a menu system used, or are function keys required? Are all possible options available for review before a command is executed?

Help. Is the HELP function helpful? Is context-sensitive help available? Are error messages useful? Do they direct you to where further assistance is available?

Criterion 11. Vendor. When an organization purchases a project management software package, it is choosing not just a system but a vendor as well. The vendor must be technically competent and easy to work with.

Experience. Has the company been in business for an acceptable length of time? Is the business financially sound and well managed? Is project management their primary concern?

Technical Assistance. How good is the hot line? Are questions answered quickly? Can the vendor answer questions dealing with a specific project management application and not just package features?

Implementation. Can the vendor implement and support the package, or must third parties, such as dealers, provide full support? Does the vendor have a staff of high-quality consultants to assist in implementation?

Training. Does the vendor provide good training programs? Are different programs available for novice, intermediate, and expert users?

Learning from User Feedback. Does the vendor incorporate user suggestion in the development of new releases? Has the vendor introduced new releases as they were needed, and were they adequate?

Criterion 12. Cost. Cost is obviously a real concern to organization leaders. Project management software packages vary in price from approximately $100 up to $8000. However, the majority of the packages lie in the $500 to $3000 range. Those that cost above $3000 tend to be very high-end packages designed to handle extremely large-scale projects. Therefore, the limits for this evaluation will range between $0 and $3000. For this area, the software system of interest will receive the grade for the price range that it falls in, as shown in Table 2.

Table 2 - Price Ranges and Associated Grades

$ 0	to	$ 500	--	Excellent
$ 501	to	$1000	--	Very Good
$1001	to	$1500	--	Good
$1501	to	$2000	--	Satisfactory
$2001	to	$2500	--	Below Average
$2501	to	$3000	--	Poor
$3001	and up		--	Not Applicable

Summary

The approach described in this chapter has outlined the three-phase methodology used to determine which existing software packages are most suitable for AFSC project management use -- namely 1) literature review, 2) information gathering, and 3) data evaluation. Table 3 summarizes the three-phase methodology and lists the evaluation criteria.

Since subjective evaluations are being made, the sub-criteria for each criterion were listed to ensure valid and reliable results. Where it was quantifiable and appropriate, a "satisfactory" (i.e., 3) and "excellent" (i.e., 6) answer for grading purposes was listed. Using this methodology, the next chapter implements the four-stage detailed analysis of Phase 3. The information generated from this analysis will then be used to make comparisons between the various project management software packages, thus allowing conclusions to be drawn from those comparisons.

Table 3 - Three-Phase Software Evaluation Summary (page 1/2)

Phase I: Literature Review

Phase II: Information Gathering

Phase III: Data Evaluation

Stage 1: Preliminary Information Review
- Memory Constraints
- Additional Software Requirements
- Additional Hardware Requirements
- Cost

Stage 2: Demo System Review
- Primary Functionality
- Graphics
- Information Presentation

Stage 3: Minor Project
- Installation
- Tutorial
- Data Entry
- Reporting

Stage 4: Major Project

1. Project Modeling Capability
   -- Capacity of System
   -- Extensiveness of Options or Features

2. Scheduling Capability
   -- Schedule Type
   -- Scheduling Time Base
   -- Accessibility of Information

3. Resource Management
   -- Planning
   -- Leveling
   -- Tracking

4. Cost Management
   -- Planning
   -- Programming
   -- Budgeting
   -- Tracking

Table 3 - Three-Phase Software Evaluation Summary (page 2/2)

5. Tracking and Controlling Existing Projects
   -- Data Entry
   -- Analysis

6. Reporting Capability
   -- Customized Reports
   -- Quality of Output

7. Advanced Project Management Functionality
   -- Baselining
   -- Analysis
   -- Interfacing with Other Programs & Computers

8. Documentation
   -- Understandable
   -- Useable

9. Ease of Learning
   -- Hands-On Tutorial
   -- Productivity

10. Ease of Use
    -- Screen Color Mix
    -- Program Hierarchy
    -- Command Presentations
    -- Help

11. Vendor
    -- Experience
    -- Technical Assistance
    -- Implementation
    -- Training
    -- Learning from User Feedback

12. Cost

IV. Research Findings and Analysis

Overview

This chapter documents the results of the research and analysis performed. It records all steps and actions taken to implement the methodology detailed in Chapter III. The chapter starts with a discussion of the work performed by the panel of experts. This helps to establish the foundation for the subsequent evaluations performed at each phase and stage. The chapter then concludes with the overall grading results for all of the project management software systems that have passed the entire evaluation.

Expert Panel

Whenever a hands-on evaluation of software is performed, one intuitively realizes that the evaluation runs the risk of being biased due to the preferences of the evaluator; concomitantly, it can become increasingly subjective and decreasingly objective. It is difficult to prevent individual preferences from tarnishing objectivity. In an attempt to alleviate this problem, and to improve the validity of the research effort, the advice of ten experts was sought.

The composition of the panel provided breadth of experience and understanding of computer system use in project management. The members were from a wide range of policy makers and implementers who possessed the years of

expertise needed to understand the impact of the issues and to render objective recommendations. These experts called upon their experience to ensure that the methodology used for the evaluation actually tested the candidate systems in areas necessary for AFSC project management use.

The members of this panel were tasked to review the research methodology proposed, and to comment on both the approach and specific evaluation criteria. The methodology must be comprehensive if it is to effectively prevent individual biases from slanting the evaluation. Each person reviewed Chapter III and concentrated on the specific evaluation criteria and weights (where applicable) used in Phase III of the evaluation. If any severe discrepancies were roted by a panel member, the entire panel was given the opportunity to comment on the proposed change. A group consensus was reached before any changes were made to the methodology.

All the previous tests (Stages 1 - 3) were performed to simply narrow down the selection of finalists for the most in-depth portion of the evaluation -- Stage 4. This stage involved some subjective grading, and this is where the expert panel was most helpful. They aided in determining the optimal weighting of the various criteria in order to ensure that those areas most important to AFSC project managers were counted most heavily. The advice, expertise, and assistance provided by the consultants proved invaluable.

Table 4 contains the recommendations made by each panel member, as well as the average weight for each criterion. The methodology summary at the end of Chapter III contains a listing of the evaluation criteria that can be used to cross-reference criteria numbers with names.

Table 4 - Summary of Expert Panel Weightings

Panel Member	Phase III - Stage 4 Evaluation Criteria: #1	#2	#3	#4	#5	#6
Mr. Casey	8.0	8.0	8.0	8.0	8.0	8.0
Mr. Doiron	9.0	8.0	8.0	9.0	8.0	7.0
Capt Hartnett	8.0	8.0	8.0	8.0	8.0	8.0
Capt Maloney	10.0	8.0	8.0	8.0	8.0	6.0
Capt Painter	8.0	8.0	8.0	8.0	8.0	8.0
LtC Peschke	12.0	6.0	8.0	8.0	6.0	6.0
Mr. Reynolds	8.0	8.0	8.0	8.0	8.0	8.0
Capt Stansberry	8.0	8.0	8.0	8.0	8.0	8.0
Ms. VonHaven	10.0	8.0	8.0	8.0	8.0	7.0
Capt Wilkinson	9.0	8.0	8.0	8.0	8.0	6.0
Average Weights (%):	9.00	7.80	8.00	8.10	7.80	7.20

Panel Member	Phase III - Stage 4 Evaluation Criteria: #7	#8	#9	#10	#11	#12
Mr. Casey	8.0	7.0	10.0	10.0	7.0	10.0
Mr. Doiron	8.0	7.0	9.0	10.0	7.0	10.0
Capt Hartnett	8.0	7.0	10.0	10.0	7.0	10.0
Capt Maloney	8.0	6.0	8.0	10.0	9.0	11.0
Capt Painter	8.0	7.0	10.0	10.0	7.0	10.0
LtC Peschke	8.0	9.0	10.0	10.0	7.0	10.0
Mr. Reynolds	8.0	7.0	10.0	10.0	7.0	10.0
Capt Stansberry	8.0	7.0	10.0	10.0	7.0	10.0
Ms. VonHaven	5.0	10.0	10.0	10.0	6.0	10.0
Capt Wilkinson	7.0	7.0	10.0	12.0	7.0	10.0
Average Weights (%):	7.60	7.40	9.70	10.20	7.10	10.10

Sum of Average Weights = 100.00%

Phase I Results

Phase I was the Literature Review and it was designed to acquaint all readers with current information that is pertinent to this study. It established a common knowledge base upon which the research was built. The results of the literature review are documented and summarized in Chapter II.

A thumbnail sketch of the chapter shows the importance of providing timely, accurate information to decision makers. Ways to obtain this information were examined, and properly used Management Information Systems (MISs) were offered as a solution. Possible methods to avoid some common stumbling blocks when planning for and implementing computerized MISs were then discussed. The review concluded with an overview of project management and the use of personal computers. Please refer to Chapter II for more detailed information.

Phase II Results

Phase II is also known as the Information Gathering Phase. It was in this phase that as much information as possible was acquired concerning commercially available project management software systems. After painstaking examination of this software market, the researcher thoroughly documented all known project management packages, along with their manufacturers, that met the initial criteria set forth in Chapter III. The two criteria are: 1) the software must run on an IBM AT compatible machine using a DOS operating system, and 2) the software must be stored on low-density (360K) floppy disks.

At the time of this writing, there were well over one hundred project management systems available; however, only seventy-nine of the systems met the initial evaluation criteria. All the systems used for this study are listed alphabetically in Appendix C according to the manufacturers' names. This entire list is what was used as a baseline to start Phase III -- the data evaluation portion of the study.

Phase III Results

The results of this section are broken down according to the four stages of the evaluation. For the first three stages, a table is shown that lists each software package being considered and tells how the system fared against the boolean evaluation criteria detailed in Chapter III. Those packages that did not pass all criteria were dropped from further consideration. The final stage (Stage 4) contains a similar list of software packages that have made it to that stage; however, in the final stage each package was evaluated and given an actual grade (from 0 to 6) for each criterion.

Stage 1 Results. All of the project management software packages gathered in Phase II were used as input to this stage. This is the preliminary review used to highlight impertinent software, thereby preventing further, unnecessary evaluation. The focus here is to determine which manufacturers produce project management software that runs on the target computer system -- the Zenith-248 Personal Computer.

A detailed discussion of the evaluation criteria used in this stage is contained in Chapter III. However, to improve readability, each criterion is summarized in this section as a single question. The answers to these questions determined which systems passed this stage of the evaluation. The criteria are: 1) Is the software fully functional when operating within the MS-DOS imposed base memory limit of

640K?; 2) Can the software be operated without additional application software operating in the background?; 3) Can all of the software package's capabilities be accessed without the purchase of additional hardware?; and 4) Does the cost fall below the $3000 upper-limit imposed by the expert panel? A response of "yes" to a certain question indicates that the software being examined has passed that criterion.

The list of all software packages considered in this stage is shown in Table 5 in the order that they appear in Appendix A, along with the results of the evaluation. Each entry marked with an 'F' indicates a failure in that particular criterion. Passing a criterion is indicated by blank spaces in order to improve readability. All systems that received one or more 'F' responses were considered to have failed Stage 1. Only those systems that passed all four criteria were considered acceptable, and continued on to the next stage of the evaluation.

Table 5 - Results of Stage 1 Evaluation (page 1/3)

Software System	Mem	Add S/W	Add H/W	Cost
1. TIMETABLE				F
2. PC-WINGS				F
3. PAC MICRO				
4. Topdown Project Planner				
5. AlderGraf Scheduling System				
6. ASAPMS/Housekeeper				
7. Project Workbench-Advanced				
8. Project Workbench-Standard				
9. Skyline				
10. Panorama	F			F
11. Who-What-When				
12. Timepiece				
13. ViewPoint				
14. SuperProject Expert				
15. SuperProject Plus				
16. PlanTRAC Mark 4B	F			F
17. PlanTrac/1				
18. Data*Easy Project Scheduler				
19. Dekker Trakker Plus				F
20. Dekker Trakker				
21. Dekker Trakker Junior				
22. DEMI-Plan				
23. Milestone				
24. AMS Time Machine				F
25. MicroGantt				
26. CPM/PERT Program				
27. Project Calc/Resources		F		
28. GANTT-PACK Work Processor				
29. SYZYGY				
30. Project:Vision Level 2				

Table 5 - Results of Stage 1 Evaluation (page 2/3)

Software System	Mem	Add S/W	Add H/W	Cost
31. InstaPlan				
32. PRESTIGE PC		F		F
33. Critical Path Project Mgmt				
34. MSCS Micro	F			F
35. Artemis Project		F		F
36. Micro-Frame Project Manager				F
37. Micro Planner (4000)				
38. Micro Planner (2000)				
39. Micro Planner for Windows		F	F	
40. Micro Planner (500)				
41. PROJECT/1-80				
42. Microsoft Project 4.0				
43. MAPPS-PC				F
44. Quick Plan II				
45. MPMS:PERT6				F
46. TASK MONITOR - PC				
47. EasyGantt				
48. MULTITRAK				F
49. VUE				
50. PMS-II (with RMS-II)				
51. PMS-II				
52. PMS 80 Advanced				F
53. MicroMan II				
54. Integrated Proj Mgmt System				F
55. Finest Hour				F
56. Project Planner				F
57. Project Cost Model				
58. PERT+				
59. Netcon I and II				
60. PertMaster Advance				

Table 5 - Results of Stage 1 Evaluation (page 3/3)

Software System	Mem	Add S/W	Add H/W	Cost
61. QWIKNET Professional				
62. QWIKNET 2.0 (500)				
63. dProject				
64. Project Scheduler 4			F	
65. Project Scheduler 5000			F	
66. MicroPERT 1				
67. MicroPERT 0				
68. MISTER-PC				F
69. ProjectMaster				
70. Pro*Path*Plus P.M. System				
71. Scheduling & Control				
72. MicroTrak				
73. Harvard Project Manager				
74. Promis	F			
75. Project Outlook		F		
76. Time Line 3.0				
77. VISIONmicro				
78. VUE Project Mgmt System				
79. OPEN PLAN		F		F

Stage 2 Results. The second stage of the evaluation was designed to examine the software packages that passed Stage 1 and to highlight those that would be neither easy nor desireable for project management use. Twenty-five packages were dropped from further consideration as a result of Stage 1, leaving fifty-four to be evaluated in Stage 2. In this stage, demonstration diskettes provided by the manufacturers were examined. If no demo disks were available, then printed output (i.e., hard copy) delivered by the manufacturer and representing the various activities that each system could perform was examined. If nothing was available for review, then the vendors were contacted and verbally asked the evaluation criteria. If they did not admit to being deficient in any of the three criteria, then the software was allowed to default to Stage 3.

As in the previous stage, the evaluation criteria are explained in detail in Chapter III. They are summarized as follows: 1) Does the system perform the primary project management functions of schedule generation, resource allocation, and cost analysis?; 2) Is the system graphics-based?; and 3) Is the information presented in an easy-to-use format? Each system that passed the previous stage was evaluated using these criteria, and the results are presented in Table 6.

The table also shows the media used to perform the evaluation (i.e., either a demonstration diskette or printed

output). A hyphen (-) in both media columns indicates that neither was available, and an 'F' in any column indicates a failure. Therefore, if a failure is shown under a criterion for which no media was available, then the vendor verbally admitted being deficient. The last column is used to show which vendors were nonresponsive. Failures for nonresponsiveness were assigned when vendors said they would participate in the evaluation by sending information, but no information was received.

Table 6 - Results of Stage 2 Evaluation (page 1/2)

Software System	Demo Disk	Hard Copy	Prim Func	Grap hics	Info Pres	Respo nsive
3. PAC MICRO	-	Y				
4. Topdown Project Planner	-	-	F	F		
5. AlderGraf Scheduling System	-	-				
6. ASAPMS/Housekeeper	-	-				
7. Project Workbench-Advanced	Y	Y				
8. Project Workbench-Standard	-	-				
9. Skyline	-	-		F		
11. Who-What-When	-	-	F	F		
12. Timepiece	-	-	F			
13. ViewPoint	Y	Y				
14. SuperProject Expert	-	-				
15. SuperProject Plus	-	-				
17. PlanTrac/1	-	-				
18. Data*Easy Project Scheduler	-	-	F	F		
20. Dekker Trakker	Y	-				
21. Dekker Trakker Junior	-	-	F			
22. DEMI-Plan	-	-	F	F		
23. Milestone	-	-		F		
25. MicroGantt	-	-	F			
26. CPM/PERT Program	-	-	F			
28. GANTT-PACK Work Processor	-	-	F			
29. SYZYGY	-	Y	F			
30. Project:Vision Level 2	-	Y				
31. InstaPlan	-	-				
33. Critical Path Project Mgmt	-	-	F			
37. Micro Planner (4000)	Y	-				
38. Micro Planner (2000)	-	Y				
40. Micro Planner (500)	-	Y				
41. PROJECT/1-80	-	-				
42. Microsoft Project 4.0	-	-				

Table 6 - Results of Stage 2 Evaluation (page 2/2)

Software System	Demo Disk	Hard Copy	Prim Func	Grap hics	Info Pres	Respo nsive
44. Quick Plan II	-	-	F			
46. TASK MONITOR - PC	Y	Y				
47. EasyGantt	-	-	F			
49. VUE	Y	Y				
50. PMS-II (with RMS-II)	Y	Y				
51. PMS-II	Y	-	F			
53. MicroMan II	Y	-				
57. Project Cost Model	-	-	F			
58. PERT+	Y	-				
59. Netcon I and II	-	-				F
60. PertMaster Advance	-	Y				
61. QWIKNET Professional	Y	-				
62. QWIKNET 2.0 (500)	-	-				
63. dProject	-	-				F
66. MicroPERT 1	-	-	F			
67. MicroPERT 0	-	-	F			
69. ProjectMaster	-	-				
70. Pro*Path*Plus P.M. System	-	-				
71. Scheduling & Control	-	-	F	F		
72. MicroTr[illegible]	-	Y				
73. Harvard Project Manager	-	-				
76. Time Line 3.0	-	-				
77. VISIONmicro	Y	-				
78. VUE Project Mgmt System	Y	Y	F	F	F	

Stage 3 Results. The evaluation then turned to actual use of the software packages that had made it to Stage 3. This was the first time that the systems were actually operated. Of the fifty-four software packages that made it to Stage 2, twenty-three were disqualified, leaving thirty-one to enter Stage 3. Individually, each of the qualifying software packages was installed on a Zenith-248 personal computer. If a tutorial was available, it was examined in this phase prior to entering data. Once a fundamental working knowledge of the system had been established, the benchmark minor project outlined in Appendix C was entered.

The overriding concern in this stage is useability. The evaluation was aimed at determining which software packages allow the project manager to quickly become productive. Those systems that are difficult to learn or use, or that are poorly documented, were quickly identified and failed.

For this stage of the study, an evaluation copy of the software being considered was reviewed. Some vendors were willing to provide complete copies of their software for evaluation purposes, while others allowed only scaled-down versions to be examined. In either case, they were actual working copies of the software, not demonstration diskettes. The scaled-down systems tended to limit the number of activities that could be entered to approximately thirty-five, although some went as high as fifty. The benchmark minor project has approximately forty activities. Therefore,

if the scaled-down evaluation copy of the software was adequate, it was used. Otherwise, the complete system was required. Some vendors were reluctant to participate without having their packages purchased. This had the effect of preventing quite a few systems from being further considered, since the researcher was not in a position to obligate the Government for the purchase of software. Those vendors that would not provide an acceptable temporary evaluation copy of their system were considered nonresponsive and failed this stage.

Besides nonresponsiveness, there are other factors that could cause a system not to pass Stage 3. They are listed below along with a summarizing question. The first area is installation. Can the software be installed quickly and easily by someone who has only an elementary understanding of the DOS operating system? The second area examines the tutorial. Does a tutorial exist, and if so, is it helpful? The third point involves data entry. Can the various types of project management data be entered quickly and easily? The final point looks at report generation. Can a report be produced on the screen, and then sent to the printer?

All of the areas in the previous paragraph examined only rudimentary operations. This phase of the examination could apply to most types of software being evaluated. However, this makes the point no less important. Ease of understanding and use of any new tool is imperative to its

acceptance by new users. If further information is desired, the evaluation criteria are discussed in detail in Chapter III.

Table 7 shows the results of the Stage 3 evaluation. It is formatted in the same manner as the previous two stages, listing the evaluation criteria across the top and the systems that made it to this stage along the left side. A failure in any criterion is marked with an 'F'. As before, only those systems that pass all criteria will be allowed to continue on to the fourth and final stage of the evaluation.

Table 7 - Results of Stage 3 Evaluation

Software System	Installation	Tutor	Data Entry	Report	Responsive
3. PAC MICRO			F		
5. AlderGraf Scheduling System					
6. ASAPMS/Housekeeper		F			
7. Project Workbench-Advanced					
8. Project Workbench-Standard					F
13. ViewPoint					
14. SuperProject Expert					
15. SuperProject Plus					F
17. PlanTrac/1	F	F			
20. Dekker Trakker					F
30. Project:Vision Level 2		F	F		
31. InstaPlan		F	F		
37. Micro Planner (4000)					F
38. Micro Planner (2000)					F
40. Micro Planner (500)					F
41. PROJECT/1-80					F
42. Microsoft Project 4.0					
46. TASK MONITOR - PC	F	F	F		
49. VUE		F			
50. PMS-II (with RMS-II)					F
53. MicroMan II					
58. PERT+			F		
60. PertMaster Advance					
61. QWIKNET Professional					
62. QWIKNET 2.0 (500)					F
69. ProjectMaster	F	F			
70. Pro*Path*Plus P.M. System		F			
72. MicroTrak			F		
73. Harvard Project Manager					
76. Time Line 3.0					
77. VISIONmicro			F		

Stage 4 Results. This was the major stage of the evaluation, involving the use of each software system to plan, track, and report on an actual government defense contract. As was stated in Chapter III, the intent of this stage was not to thoroughly test each system's full capacity and capability; rather, an actual contract was used to exercise the candidate systems in the same manner that Air Force managers will (i.e., normal use). Appendix D contains an overview of the benchmark major project, an activity breakdown, and pertinent reports.

Thirty-one software packages entered Stage 3. Of these, twenty-one failed at least one criterion, thus leaving ten packages to enter Stage 4. Table 8 shows the software systems that passed the first three stages and were examined in this stage. The complete software system, including documentation, was required for this stage. Of the ten systems listed, only one vendor was unwilling to deliver a complete copy of the software for evaluation purposes. The AlderGraf Scheduling System was dropped from further consideration for this reason. This left nine systems for competition in the twelve categories discussed in Chapter III. The twelve evaluation criteria and their associated weights are summarized in Table 9. The grading scale, as shown in Chapter III, is reprinted in Figure 1 for reference.

Tables 10 through 18 contain the results of the fourth stage evaluation, with one table being used for each system

considered. Each evaluation criterion was broken down into several components, and each component was graded separately. The results of these component scores, or "sub-scores", were then averaged, yielding a grade for each criterion. The weight associated with the criterion was then multiplied with the average grade. This product furnished the contribution of the criterion grade to the overall score.

Table 8 - Candidate Stage 4 Software Packages

7.	Project Workbench-Advanced
13.	ViewPoint
14.	SuperProject Expert
42.	Microsoft Project 4.0
53.	MicroMan II
60.	PertMaster Advance
61.	QWIKNET Professional
73.	Harvard Project Manager
76.	Time Line 3.0

Table 9 - Summary of Stage 4 Evaluation Criteria

1.	Project Modeling Capability	9.0%
2.	Scheduling Capability	7.8%
3.	Resource Management	8.0%
4.	Cost Management	8.1%
5.	Tracking and Controlling Existing Projects	7.8%
6.	Reporting Capability	7.2%
7.	Advanced Project Management Functionality	7.6%
8.	Documentation	7.4%
9.	Ease of Learning	9.7%
10.	Ease of Use	10.2%
11.	Vendor	7.1%
12.	Cost	10.1%
		100.0%

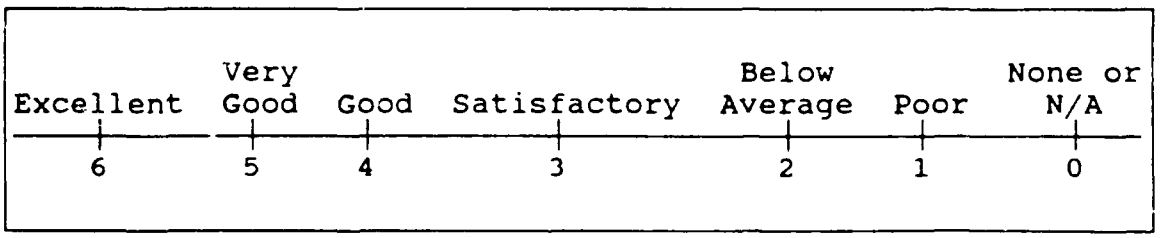

Figure 1 - Grading Scale

Table 10 - Stage 4 Results for Project Workbench (page 1/2)

PROJECT WORKBENCH - ADVANCED

Evaluation Criteria	Sub Scores	Criteria Grades	Wgt	Criteria Scores
1. Project Modeling Capability:				
- Capacity of System	4			
- Options and Features	3			
		7 / 2 = 3.50	.090	0.315
2. Scheduling Capability:				
- Schedule Type	5			
- Scheduling Time Base	4			
- Accessibility of Info	2			
		11 / 3 = 3.67	.078	0.286
3. Resource Management:				
- Planning	4			
- Leveling	4			
- Tracking	5			
		13 / 3 = 4.33	.080	0.346
4. Cost Management:				
- Planning	3			
- Programming	5			
- Budgeting	5			
- Tracking	3			
		16 / 4 = 4.00	.081	0.324
5. Track/Control Projects:				
- Data Entry	5			
- Analysis	2			
		7 / 2 = 3.50	.078	0.273
6. Reporting Capability:				
- Customized Reports	3			
- Quality of Output	4			
		7 / 2 = 3.50	.072	0.252

Table 10 - Stage 4 Results for Project Workbench (page 2/2)

Evaluation Criteria	Sub Scores	Criteria Grades	Wgt	Criteria Scores
7. **Advanced P.M. Functionality:**				
- Baselining	2			
- Analyses	4			
- Interfacing	2			
	8 / 3 = 2.67		.076	0.203
8. Documentation:				
- Understandable	5			
- Useable	5			
	10 / 2 = 5.00		.074	0.370
9. Ease of Learning:				
- Hands-on Tutorial	4			
- Productivity	5			
	9 / 2 = 4.50		.097	0.437
10. Ease of Use:				
- Screen Color Mix	3			
- Program Hierarchy	5			
- Command Presentations	4			
- Help	5			
	17 / 4 = 4.25		.102	0.434
11. Vendor:				
- Experience	3			
- Technical Assistance	3			
- Implementation	5			
- Training	3			
- User Feedback	6			
	20 / 5 = 4.00		.071	0.284
12. Cost:				
- $1275 is in "good" range		4.00	.101	0.404
PROJECT WORKBENCH - ADVANCED Overall Score = 3.928				

Table 11 - Stage 4 Results for ViewPoint (page 1/2)

Evaluation Criteria	Sub Scores	Criteria Grades	Wgt	Criteria Scores
	VIEWPOINT			
1. Project Modeling Capability:				
- Capacity of System	6			
- Options/Features	4			
		10 / 2 = 5.00	.090	0.450
2. Scheduling Capability:				
- Schedule Type	5			
- Scheduling Time Base	4			
- Accessibility of Info	4			
		13 / 3 = 4.33	.078	0.338
3. Resource Management:				
- Planning	3			
- Leveling	5			
- Tracking	4			
		12 / 3 = 4.00	.080	0.320
4. Cost Management:				
- Planning	4			
- Programming	5			
- Budgeting	5			
- Tracking	5			
		19 / 4 = 4.75	.081	0.385
5. Track/Control Projects:				
- Data Entry	5			
- Analysis	4			
		9 / 2 = 4.50	.078	0.351
6. Reporting Capability:				
- Customized Reports	5			
- Quality of Output	5			
		10 / 2 = 5.00	.072	0.360

Table 11 - Stage 4 Results for ViewPoint (page 2/2)

Evaluation Criteria	Sub Scores	Criteria Grades	Wgt	Criteria Scores
7. **Advanced P.M. Functionality:**				
- Baselining	4			
- Analyses	5			
- Interfacing	5			
	14	/ 3 = 4.67	.076	0.355
8. Documentation:				
- Understandable	5			
- Useable	5			
	10	/ 2 = 5.00	.074	0.370
9. Ease of Learning:				
- Hands-on Tutorial	4			
- Productivity	3			
	7	/ 2 = 3.50	.097	0.340
10. Ease of Use:				
- Screen Color Mix	1			
- Program Hierarchy	3			
- Command Presentations	4			
- Help	5			
	13	/ 4 = 3.25	.102	0.332
11. Vendor:				
- Experience	4			
- Technical Assistance	3			
- Implementation	5			
- Training	2			
- User Feedback	0			
	14	/ 5 = 2.80	.071	0.199
12. Cost:				
- $2990 is in "poor" range		1.00	.101	0.101
VIEWPOINT Overall Score = 3.901				

Table 12 - Stage 4 Results for SuperProject Expert (page 1/2)

SUPERPROJECT EXPERT

Evaluation Criteria	Sub Scores	Criteria Grades	Wgt	Criteria Scores
1. Project Modeling Capability:				
- Capacity of System	3			
- Options/Features	4			
		7 / 2 = 3.50	.090	0.315
2. Scheduling Capability:				
- Schedule Type	5			
- Scheduling Time Base	3			
- Accessibility of Info	4			
		12 / 3 = 4.00	.078	0.312
3. Resource Management:				
- Planning	5			
- Leveling	3			
- Tracking	5			
		13 / 3 = 4.33	.080	0.346
4. Cost Management:				
- Planning	2			
- Programming	2			
- Budgeting	5			
- Tracking	4			
		13 / 4 = 3.25	.081	0.263
5. Track/Control Projects:				
- Data Entry	5			
- Analysis	3			
		8 / 2 = 4.00	.078	0.312
6. Reporting Capability:				
- Customized Reports	5			
- Quality of Output	4			
		9 / 2 = 4.50	.072	0.324

Table 12 - Stage 4 Results for SuperProject Expert (page 2/2)

Evaluation Criteria	Sub Scores	Criteria Grades	Wgt	Criteria Scores
7. **Advanced P.M. Functionality:**				
- Baselining	0			
- Analyses	3			
- Interfacing	5			
	8 / 3 = 2.67		.076	0.203
8. Documentation:				
- Understandable	5			
- Useable	4			
	9 / 2 = 4.50		.074	0.333
9. Ease of Learning:				
- Hands-on Tutorial	5			
- Productivity	5			
	10 / 2 = 5.00		.097	0.485
10. Ease of Use:				
- Screen Color Mix	5			
- Program Hierarchy	4			
- Command Presentations	3			
- Help	4			
	16 / 4 = 4.00		.102	0.408
11. Vendor:				
- Experience	1			
- Technical Assistance	3			
- Implementation	5			
- Training	0			
- User Feedback	0			
	9 / 5 = 1.80		.071	0.128
12. Cost:				
- $695 is in "very good" range		5.00	.101	0.505
SUPERPROJECT EXPERT Overall Score = 3.934				

Table 13 - Stage 4 Results for Microsoft Project (page 1/2)

MICROSOFT PROJECT

Evaluation Criteria	Sub Scores	Criteria Grades	Wgt	Criteria Scores
1. Project Modeling Capability:				
- Capacity of System	2			
- Options/Features	3			
		5 / 2 = 2.50	.090	0.225
2. Scheduling Capability:				
- Schedule Type	5			
- Scheduling Time Base	5			
- Accessibility of Info	5			
		15 / 3 = 5.00	.078	0.390
3. Resource Management:				
- Planning	2			
- Leveling	2			
- Tracking	3			
		7 / 3 = 2.33	.080	0.186
4. Cost Management:				
- Planning	2			
- Programming	0			
- Budgeting	5			
- Tracking	4			
		11 / 4 = 2.75	.081	0.223
5. Track/Control Projects:				
- Data Entry	5			
- Analysis	3			
		8 / 2 = 4.00	.078	0.312
6. Reporting Capability:				
- Customized Reports	3			
- Quality of Output	5			
		8 / 2 = 4.00	.072	0.288

Table 13 - Stage 4 Results for Microsoft Project (page 2/2)

Evaluation Criteria	Sub Scores	Criteria Grades	Wgt	Criteria Scores
7. **Advanced P.M. Functionality:**				
- Baselining	0			
- Analyses	1			
- Interfacing	5			
		6 / 3 = 2.00	.076	0.152
8. Documentation:				
- Understandable	2			
- Useable	3			
		5 / 2 = 2.50	.074	0.185
9. Ease of Learning:				
- Hands-on Tutorial	5			
- Productivity	5			
		10 / 2 = 5.00	.097	0.485
10. Ease of Use:				
- Screen Color Mix	5			
- Program Hierarchy	5			
- Command Presentations	5			
- Help	2			
		17 / 4 = 4.25	.102	0.434
11. Vendor:				
- Experience	1			
- Technical Assistance	5			
- Implementation	5			
- Training	1			
- User Feedback	0			
		12 / 5 = 2.40	.071	0.170
12. Cost:				
- $495 is in "excellent" range		5.00	.101	0.505
MICROSOFT PROJECT Overall Score = 3.555				

Table 14 - Stage 4 Results for MicroMan II (page 1/2)

MICROMAN II

Evaluation Criteria	Sub Scores	Criteria Grades	Wgt	Criteria Scores
1. Project Modeling Capability:				
- Capacity of System	6			
- Options/Features	5			
		11 / 2 = 5.50	.090	0.495
2. Scheduling Capability:				
- Schedule Type	5			
- Scheduling Time Base	1			
- Accessibility of Info	4			
		10 / 3 = 3.33	.078	0.260
3. Resource Management:				
- Planning	5			
- Leveling	5			
- Tracking	5			
		15 / 3 = 5.00	.080	0.400
4. Cost Management:				
- Planning	4			
- Programming	2			
- Budgeting	5			
- Tracking	5			
		16 / 4 = 4.00	.081	0.324
5. Track/Control Projects:				
- Data Entry	5			
- Analysis	5			
		10 / 2 = 5.00	.078	0.390
6. Reporting Capability:				
- Customized Reports	5			
- Quality of Output	5			
		10 / 2 = 5.00	.072	0.360

Table 14 - Stage 4 Results for MicroMan II (page 2/2)

Evaluation Criteria	Sub Scores	Criteria Grades	Wgt	Criteria Scores
7. **Advanced P.M. Functionality:**				
- Baselining	4			
- Analyses	5			
- Interfacing	5			
	14 / 3 = 4.67		.076	0.355
8. Documentation:				
- Understandable	4			
- Useable	5			
	9 / 2 = 4.50		.074	0.333
9. Ease of Learning:				
- Hands-on Tutorial	3			
- Productivity	4			
	7 / 2 = 3.50		.097	0.340
10. Ease of Use:				
- Screen Color Mix	3			
- Program Hierarchy	3			
- Command Presentations	3			
- Help	5			
	14 / 4 = 3.50		.102	0.357
11. Vendor:				
- Experience	2			
- Technical Assistance	5			
- Implementation	5			
- Training	3			
- User Feedback	3			
	18 / 5 = 3.60		.071	0.256
12. Cost:				
- $2990 is in "poor" range		1.00	.101	0.101
MICROMAN II Overall Score = 3.971				

Table 15 - Stage 4 Results for PertMaster Advance (page 1/2)

PERTMASTER ADVANCE

Evaluation Criteria	Sub Scores	Criteria Grades	Wgt	Criteria Scores
1. Project Modeling Capability:				
- Capacity of System	3			
- Options/Features	3			
	6	/ 2 = 3.00	.090	0.270
2. Scheduling Capability:				
- Schedule Type	5			
- Scheduling Time Base	5			
- Accessibility of Info	5			
	15	/ 3 = 5.00	.078	0.390
3. Resource Management:				
- Planning	4			
- Leveling	3			
- Tracking	5			
	12	/ 3 = 4.00	.080	0.320
4. Cost Management:				
- Planning	2			
- Programming	0			
- Budgeting	5			
- Tracking	4			
	11	/ 4 = 2.75	.081	0.223
5. Track/Control Projects:				
- Data Entry	5			
- Analysis	2			
	7	/ 2 = 3.50	.078	0.273
6. Reporting Capability:				
- Customized Reports	2			
- Quality of Output	4			
	6	/ 2 = 3.00	.072	0.216

Table 15 - Stage 4 Results for PertMaster Advance (page 2/2)

Evaluation Criteria	Sub Scores	Criteria Grades	Wgt	Criteria Scores
7. Advanced P.M. Functionality:				
- Baselining	1			
- Analyses	3			
- Interfacing	4			
		8 / 3 = 2.67	.076	0.203
8. Documentation:				
- Understandable	1			
- Useable	1			
		2 / 2 = 1.00	.074	0.074
9. Ease of Learning:				
- Hands-on Tutorial	2			
- Productivity	4			
		6 / 2 = 3.00	.097	0.291
10. Ease of Use:				
- Screen Color Mix	5			
- Program Hierarchy	4			
- Command Presentations	4			
- Help	5			
		18 / 4 = 4.50	.102	0.459
11. Vendor:				
- Experience	2			
- Technical Assistance	3			
- Implementation	5			
- Training	2			
- User Feedback	0			
		12 / 5 = 2.40	.071	0.170
12. Cost:				
- $1990 is in "satisfactory" range		3.00	.101	0.303
PERTMASTER ADVANCE Overall Score = 3.192				

Table 16 - Stage 4 Results for QWIKNET Professional (p. 1/2)

QWIKNET PROFESSIONAL

Evaluation Criteria	Sub Scores	Criteria Grades	Wgt	Criteria Scores
1. Project Modeling Capability:				
- Capacity of System	4			
- Options/Features	5			
		9 / 2 = 4.50	.090	0.405
2. Scheduling Capability:				
- Schedule Type	5			
- Scheduling Time Base	5			
- Accessibility of Info	5			
		15 / 3 = 5.00	.078	0.390
3. Resource Management:				
- Planning	5			
- Leveling	3			
- Tracking	5			
		13 / 3 = 4.33	.080	0.346
4. Cost Management:				
- Planning	4			
- Programming	5			
- Budgeting	5			
- Tracking	6			
		20 / 4 = 5.00	.081	0.405
5. Track/Control Projects:				
- Data Entry	5			
- Analysis	5			
		10 / 2 = 5.00	.078	0.390
6. Reporting Capability:				
- Customized Reports	5			
- Quality of Output	5			
		10 / 2 = 5.00	.072	0.360

Table 16 - Stage 4 Results for QWIKNET Professional (p. 2/2)

Evaluation Criteria	Sub Scores	Criteria Grades	Wgt	Criteria Scores
7. Advanced P.M. Functionality:				
- Baselining	6			
- Analyses	5			
- Interfacing	2			
	13 / 3	= 4.33	.076	0.329
8. Documentation:				
- Understandable	4			
- Useable	4			
	8 / 2	= 4.00	.074	0.296
9. Ease of Learning:				
- Hands-on Tutorial	3			
- Productivity	4			
	7 / 2	= 3.50	.097	0.340
10. Ease of Use:				
- Screen Color Mix	5			
- Program Hierarchy	4			
- Command Presentations	3			
- Help	5			
	17 / 4	= 4.25	.102	0.434
11. Vendor:				
- Experience	3			
- Technical Assistance	3			
- Implementation	5			
- Training	2			
- User Feedback	6			
	19 / 5	= 3.80	.071	0.270
12. Cost:				
- $2690 is in "poor" range		1.00	.101	0.101
QWIKNET PROFESSIONAL Overall Score				**= 4.066**

Table 17 - Stage 4 Results for Harvard Project Mgr (p. 1/2)

HARVARD PROJECT MANAGER

Evaluation Criteria	Sub Scores	Criteria Grades	Wgt	Criteria Scores
1. Project Modeling Capability:				
- Capacity of System	3			
- Options/Features	3			
		6 / 2 = 3.00	.090	0.270
2. Scheduling Capability:				
- Schedule Type	5			
- Scheduling Time Base	5			
- Accessibility of Info	5			
		15 / 3 = 5.00	.078	0.390
3. Resource Management:				
- Planning	4			
- Leveling	2			
- Tracking	3			
		9 / 3 = 3.00	.080	0.240
4. Cost Management:				
- Planning	2			
- Programming	0			
- Budgeting	5			
- Tracking	4			
		11 / 4 = 2.75	.081	0.223
5. Track/Control Projects:				
- Data Entry	5			
- Analysis	2			
		7 / 2 = 3.50	.078	0.273
6. Reporting Capability:				
- Customized Reports	3			
- Quality of Output	4			
		7 / 2 = 3.50	.072	0.252

Table 17 - Stage 4 Results for Harvard Project Mgr (p. 2/2)

Evaluation Criteria	Sub Scores	Criteria Grades	Wgt	Criteria Scores
7. Advanced P.M. Functionality:				
- Baselining	0			
- Analyses	2			
- Interfacing	5			
	7 / 3 = 2.33		.076	0.177
8. Documentation:				
- Understandable	5			
- Useable	5			
	10 / 2 = 5.00		.074	0.370
9. Ease of Learning:				
- Hands-on Tutorial	5			
- Productivity	6			
	11 / 2 = 5.50		.097	0.534
10. Ease of Use:				
- Screen Color Mix	5			
- Program Hierarchy	5			
- Command Presentations	5			
- Help	3			
	18 / 4 = 4.50		.102	0.459
11. Vendor:				
- Experience	1			
- Technical Assistance	4			
- Implementation	5			
- Training	0			
- User Feedback	0			
	10 / 5 = 2.00		.071	0.142
12. Cost:				
- $695 is in "very good" range		5.00	.101	0.505
HARVARD PROJECT MANAGER Overall Score =				3.835

Table 18 - Stage 4 Results for Time Line (page 1/2)

TIME LINE

Evaluation Criteria	Sub Scores	Criteria Grades	Wgt	Criteria Scores
1. Project Modeling Capability:				
- Capacity of System	3			
- Options/Features	5			
	8	/ 2 = 4.00	.090	0.360
2. Scheduling Capability:				
- Schedule Type	5			
- Scheduling Time Base	5			
- Accessibility of Info	5			
	15	/ 3 = 5.00	.078	0.390
3. Resource Management:				
- Planning	3			
- Leveling	5			
- Tracking	5			
	13	/ 3 = 4.33	.080	0.346
4. Cost Management:				
- Planning	2			
- Programming	2			
- Budgeting	5			
- Tracking	5			
	14	/ 4 = 3.50	.081	0.284
5. Track/Control Projects:				
- Data Entry	5			
- Analysis	5			
	10	/ 2 = 5.00	.078	0.390
6. Reporting Capability:				
- Customized Reports	4			
- Quality of Output	5			
	9	/ 2 = 4.50	.072	0.324

Table 18 - Stage 4 Results for Time Line (page 2/2)

Evaluation Criteria	Sub Scores	Criteria Grades	Wgt	Criteria Scores
7. Advanced P.M. Functionality:				
- Baselining	5			
- Analyses	5			
- Interfacing	2			
	12	/ 3 = 4.00	.076	0.304
8. Documentation:				
- Understandable	5			
- Useable	5			
	10	/ 2 = 5.00	.074	0.370
9. Ease of Learning:				
- Hands-on Tutorial	6			
- Productivity	6			
	12	/ 2 = 6.00	.097	0.582
10. Ease of Use:				
- Screen Color Mix	5			
- Program Hierarchy	5			
- Command Presentations	6			
- Help	5			
	21	/ 4 = 5.25	.102	0.536
11. Vendor:				
- Experience	2			
- Technical Assistance	4			
- Implementation	5			
- Training	0			
- User Feedback	3			
	14	/ 5 = 2.80	.071	0.199
12. Cost:				
- $790 is in "very good" range		5.00	.101	0.505
TIME LINE Overall Score = 4.590				

Summary

This chapter has described in detail the results of the evaluation performed on the seventy-nine commercially available project management software packages. These systems were the ones that met the initial screening criteria for the study. The panel of experts aided in validating the evaluation criteria which were subsequently applied in a three phase analysis. The detailed data evaluation of Phase III - Stage 4 can be likened to four sieves which decrease in coarseness and are sequentially used to extract the finest particles from among a conglomeration of varying size fragments. All the particles to be sifted are dropped into the top, but only the finest particles pass all the way through. The result is a collection of the finest particles. This evaluation yielded a collection of the finest software packages available for AFSC project management use, which are summarized in Table 19 and Figure 2 in descending order of overall score. What remains now is to determine what conclusions can be drawn from this "collection of the finest" software packages. That is the subject of the next and final chapter -- Chapter V.

Table 19 - Numerical Results of Phase III Evaluation

Software System	Overall Score
76. Time Line 3.0	4.590
61. QWIKNET Professional	4.066
53. MicroMan II	3.971
14. SuperProject Expert	3.934
7. Project Workbench - Advanced	3.928
13. ViewPoint	3.901
73. Harvard Project Manager	3.835
42. Microsoft Project 4.0	3.555
60. PertMaster Advance	3.192

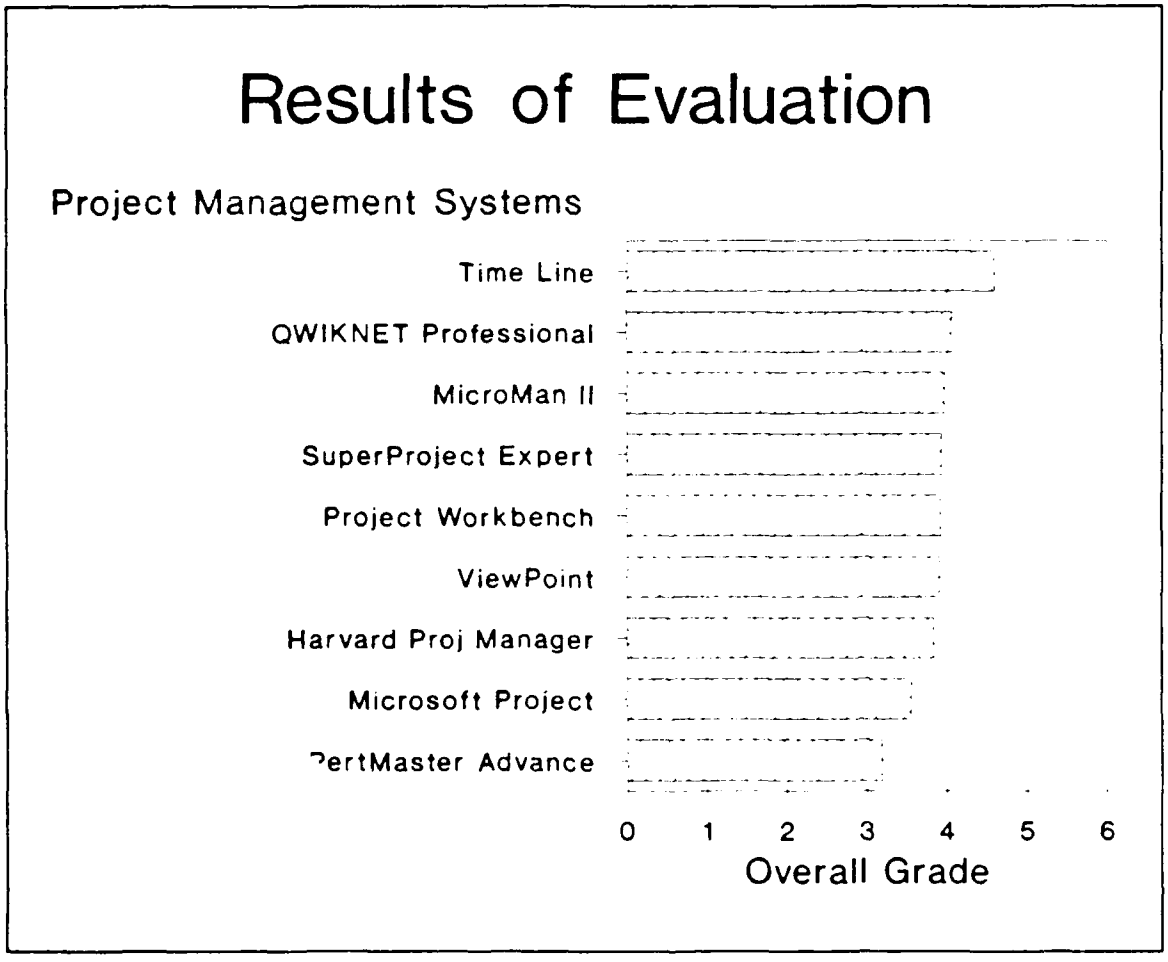

Figure 2 - Graphical Results of Phase III Evaluation

V. Conclusions and Recommendations

Overview

The purpose of this chapter is to present the conclusions derived from the analyses performed in Chapters II and IV. The results of the software evaluation of Chapter IV must be combined with the current research and public opinion contained in Chapter II in order to present practical rather than theoretical conclusions. The research objective and investigative questions posed in Chapter I are used to present the conclusions, thereby closing the research loop. The chapter closes with recommendations for future research efforts that will further this area of study and build on the existing knowledge base.

Conclusion from the Research Objective

The objective of this study was to determine which project management software packages were available, and of those systems, to ascertain which were most appropriate for AFSC project management use. The most thorough way to answer this question is to examine the six investigative questions that were designed to rigorously evaluate the research objective.

Conclusions from the Investigative Questions. As a result of the analyses performed in Chapters II and IV, conclusions can be drawn for each investigative question. They are shown in the paragraphs that follow.

1. What are the current information needs of AFSC project managers? As was stated in Chapter III, the results of Capt Handy's study were used to determine the information needs of AFSC project managers. These needs can be broken down into six knowledge work tasks and four qualitative factors. The knowledge work tasks include: 1) authoring and presentation, 2) planning and decision support, 3) monitoring and control, 4) organizing and scheduling, 5) diagnosis and problem finding, and 6) communication. The qualitative factors included: 1) interoperability and transportability of data between personal computers, mainframes, and other software types and products, 2) evaluation through demonstrations or periodicals, 3) cost considerations, and 4) other factors such as downwardly mandated software product purchases.

The six knowledge work tasks form the basis for project management systems. The project manager authors and presents the initial project schedule while keeping in mind the primary management functions of planning, organizing, staffing, directing, and controlling. This automated schedule can then be used for monitoring the project, identifying and diagnosing problems, and supporting

decisions. The software can then be used as an aide to communicate the results, through textual and graphical means, to team members and upper management.

As for the qualitative factors, interoperability and transportability of data between personal computers and other systems is demonstrated by the software's ability to import and export data. This area was examined under Phase III - Stage 4 - Criterion 7 - Interfacing with Other Programs and Computers. The evaluation methodology has accounted for the second and third factors by actually using each system and accounting for the costs. However, the fourth factor is the responsibility of upper management, as stated in the Literature Review. It is important for senior management to understand the benefits of automation, and encourage and reward computer use.

The first nine areas discussed are readily handled by most project management software systems. The criteria for evaluating the systems were developed around these stated needs and weighted as recommended by the panel of experts. By building upon the recent research of Capt Handy, this study has ensured that the current needs of project managers will be met through proper use of the recommended software system.

2. What project management software currently exists that can meet these needs? In Stage 1 of Phase III, the data collection stage, information on all commercially available project management software systems was collected. It was determined that there were 79 systems that met the initial requirements. These systems were then used in a three stage filtration process, and those that passed all three stages were rank ordered in Stage 4. The rank ordering, shown in the Chapter IV summary, represents a prioritized list of systems, from best to worst, that meet the previously stated and weighted needs of AFSC project managers.

3. What are the trade-offs between the different software packages? Figures 3 through 14 can be used to compare the strengths and weaknesses of each system, as well as determine which software package fared the best for a particular criterion. These figures graphically portray the information contained in Tables 10 through 18 (i.e., the results of each individual software package evaluation), and rank the software packages according to the grade they received for each Stage 4 criterion.

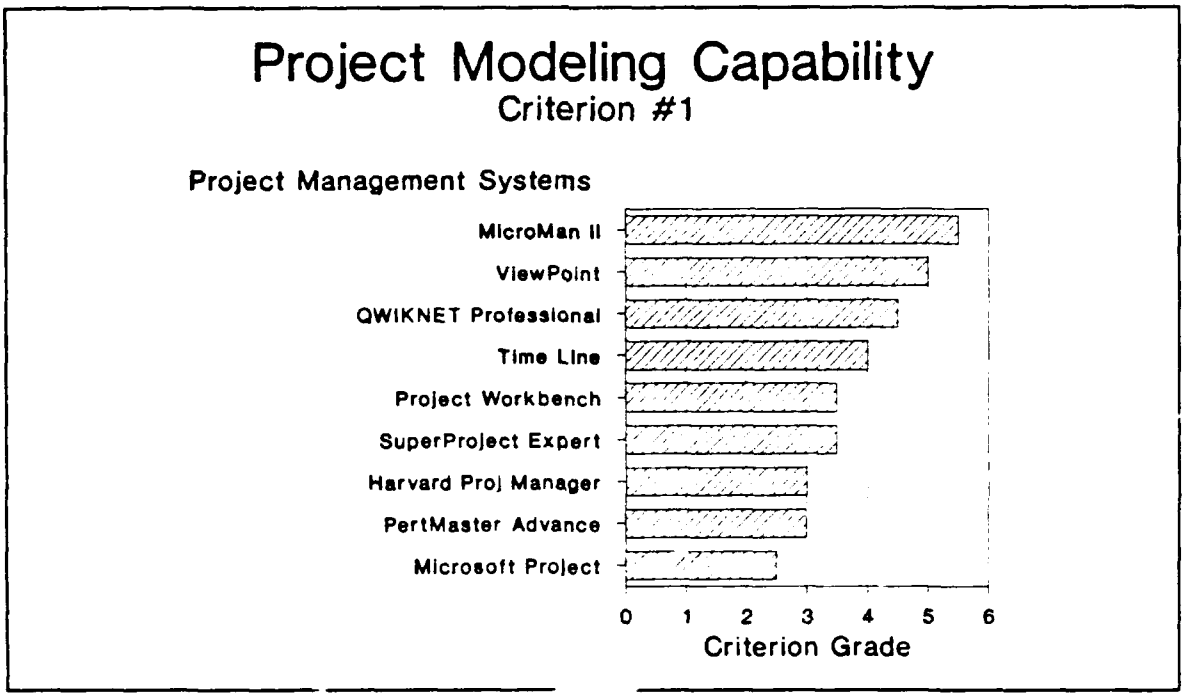

Figure 3 - Ranked Grades for Project Modeling Capability

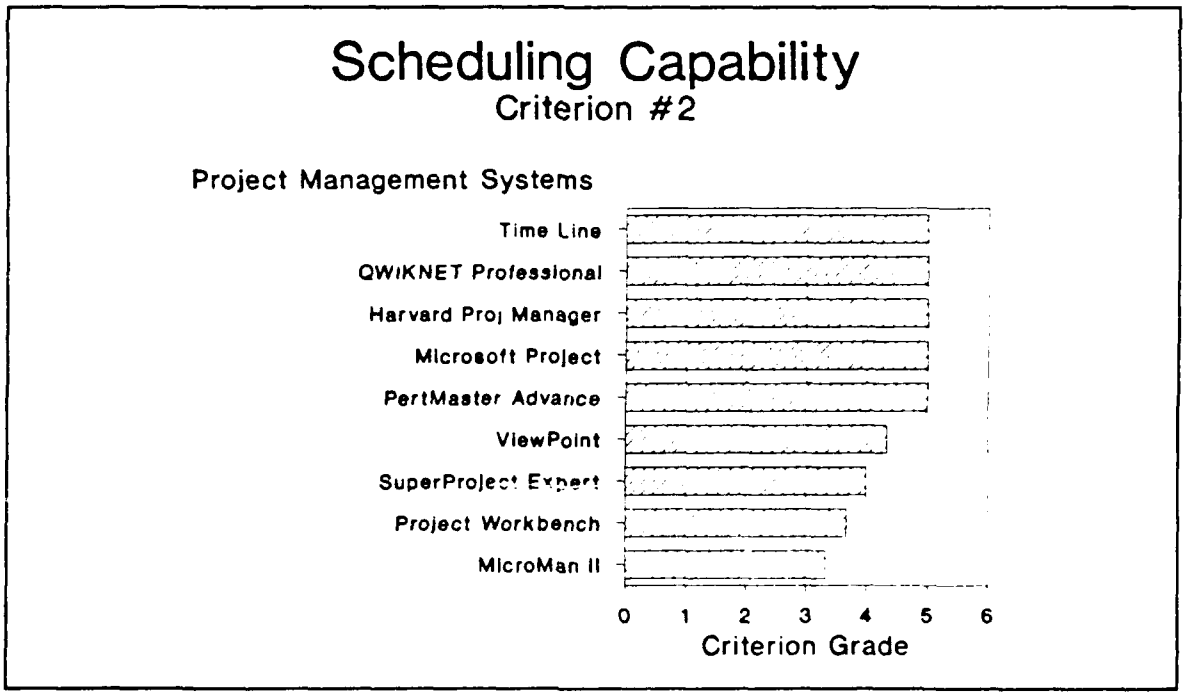

Figure 4 - Ranked Grades for Scheduling Capability

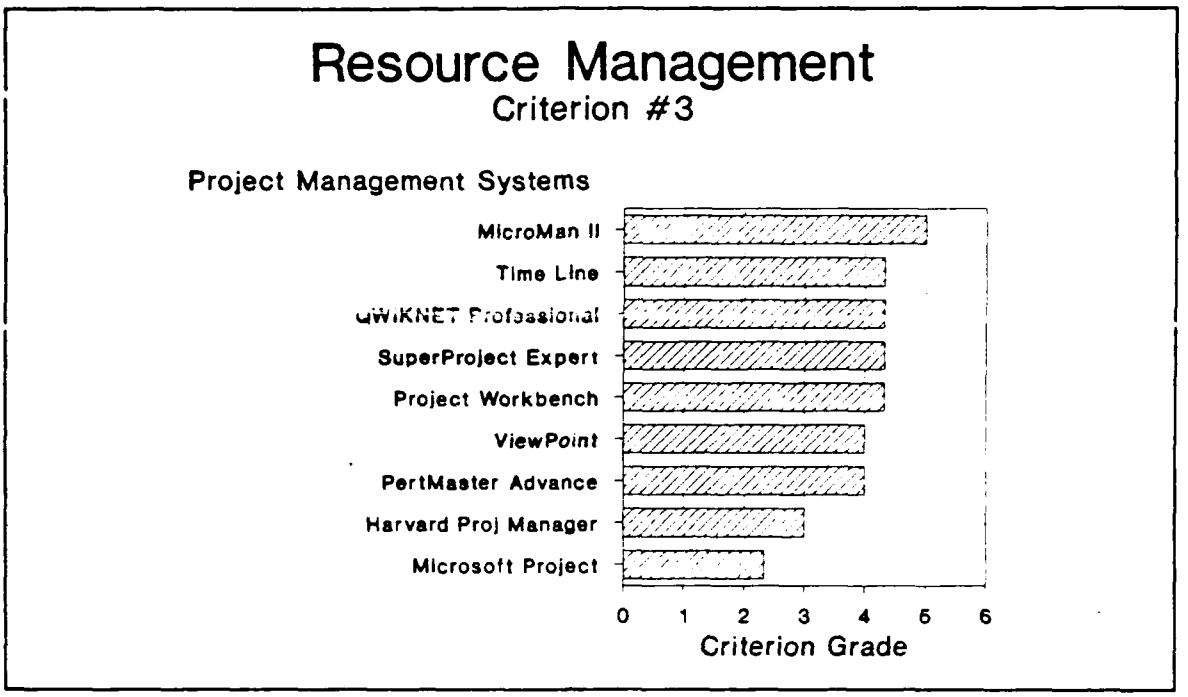

Figure 5 - Ranked Grades for Resource Management

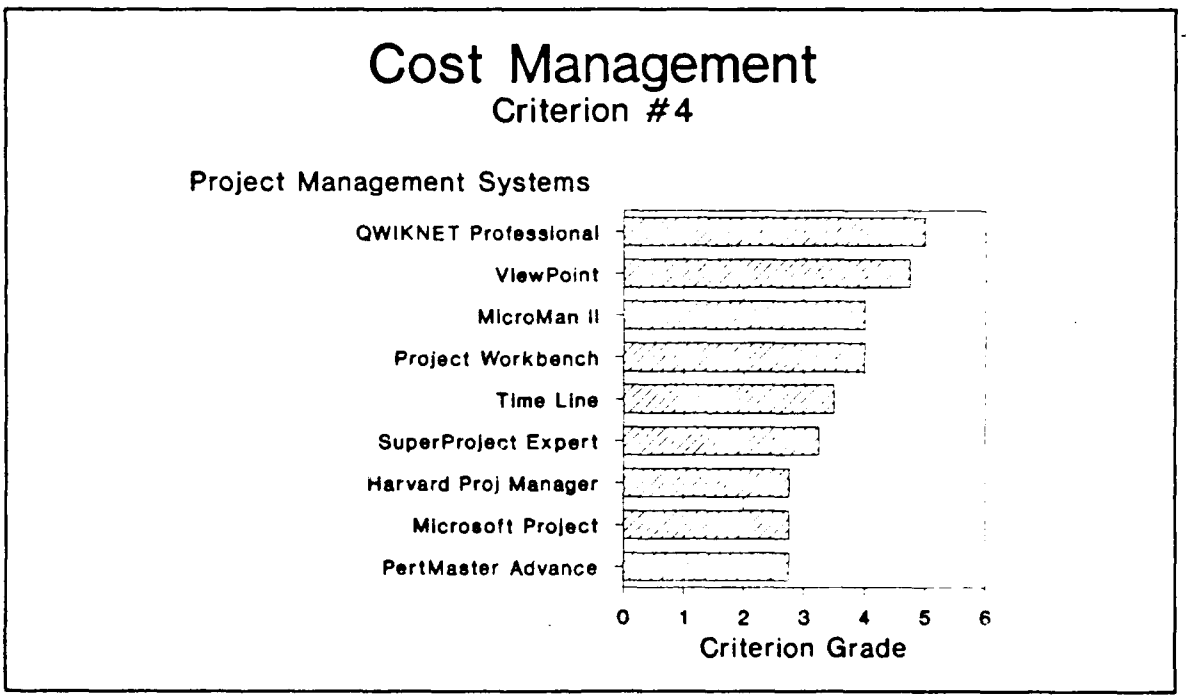

Figure 6 - Ranked Grades for Cost Management

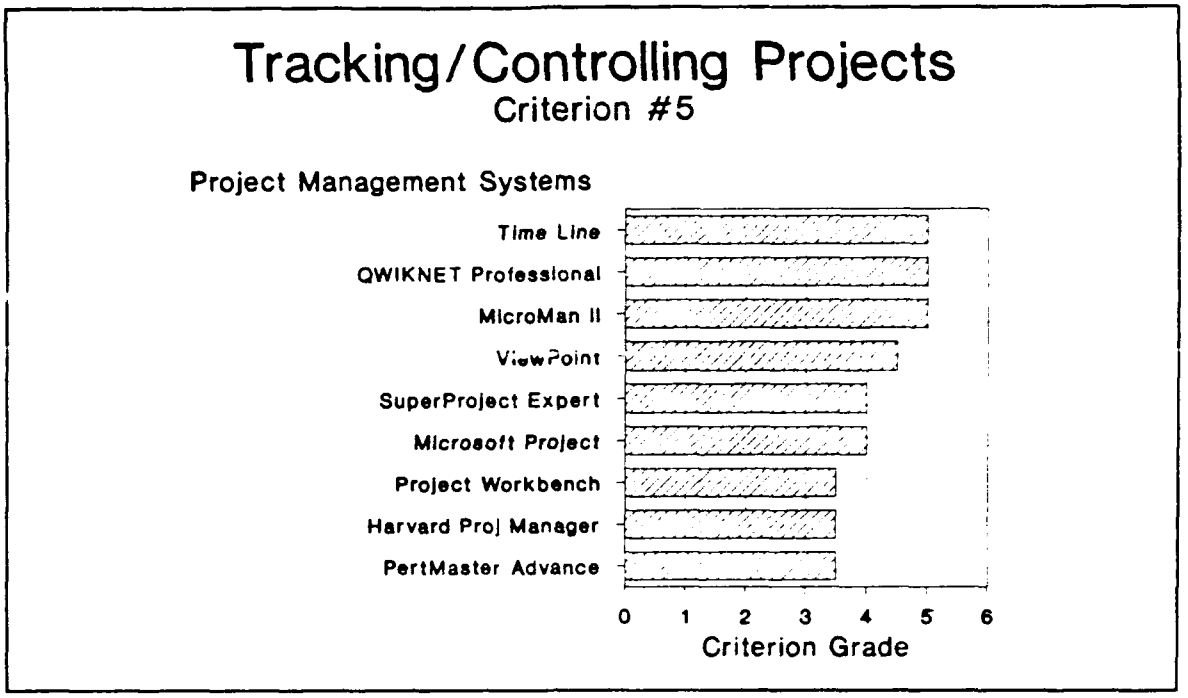

Figure 7 - Ranked Grades for Tracking/Controlling Projects

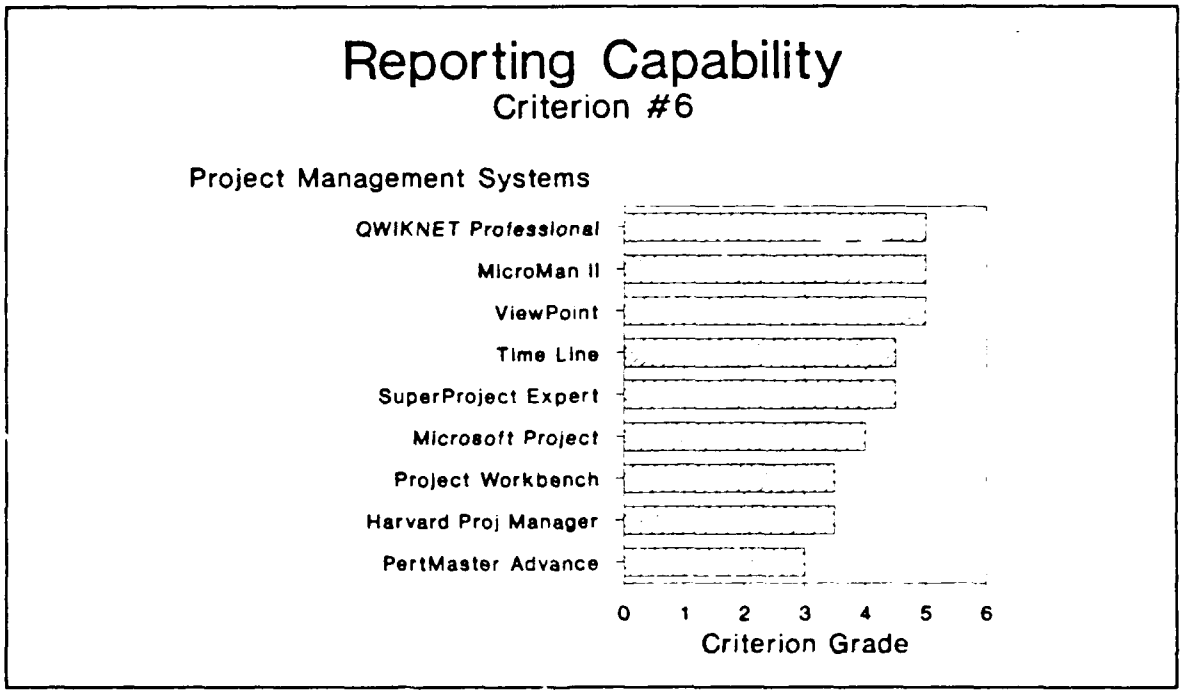

Figure 8 - Ranked Grades for Reporting Capability

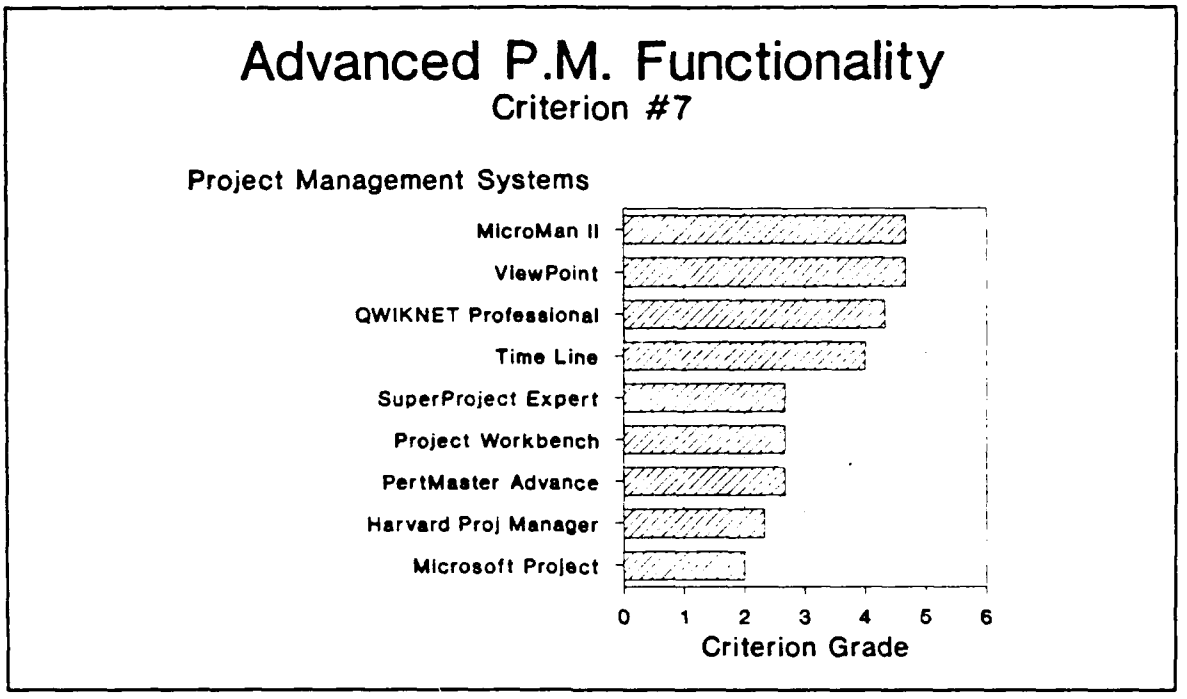

Figure 9 - Ranked Grades for Advanced P.M. Functionality

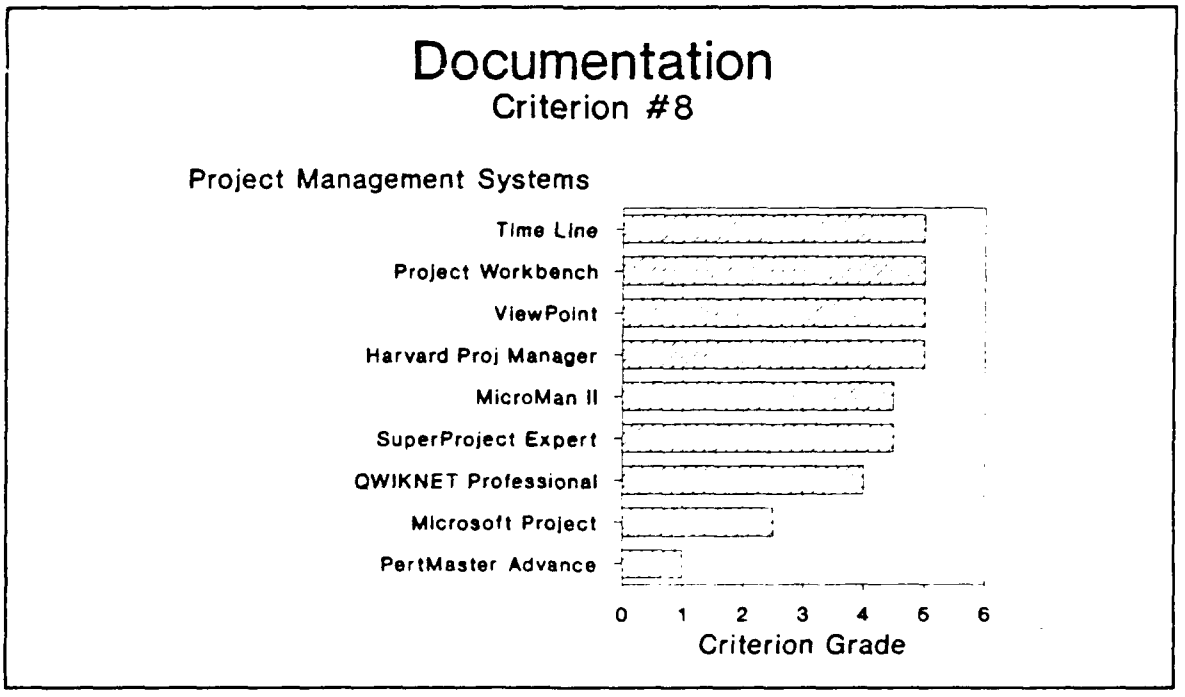

Figure 10 - Ranked Grades for Documentation

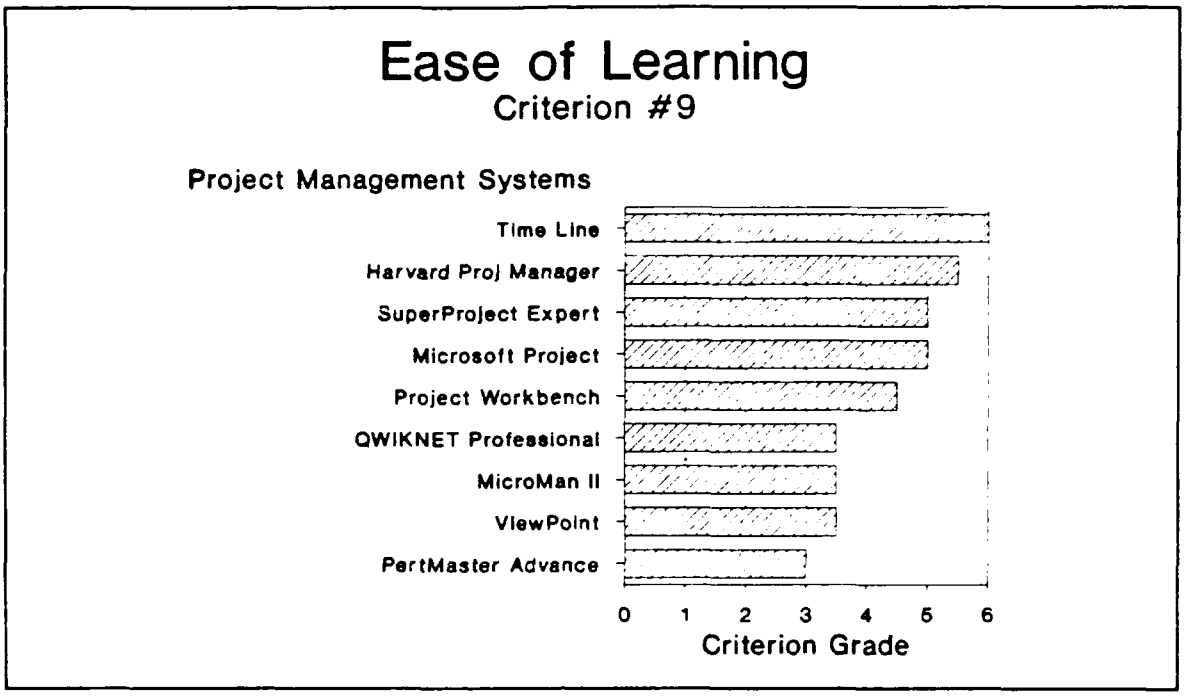

Figure 11 - Ranked Grades for Ease of Learning

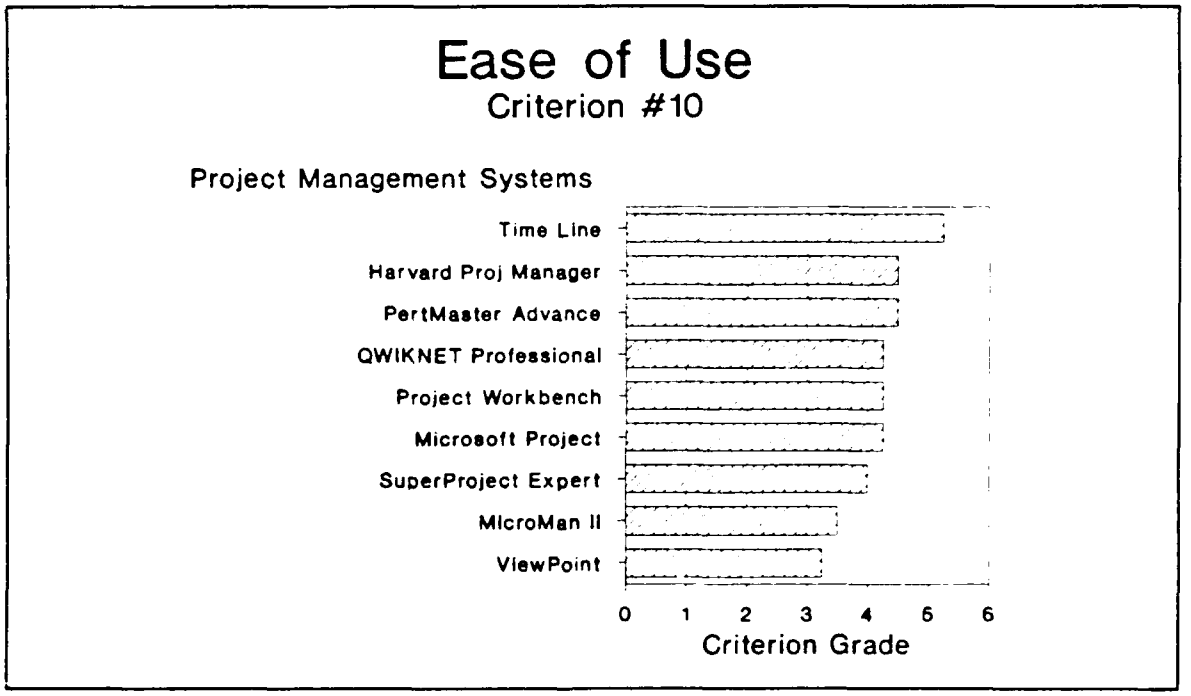

Figure 12 - Ranked Grades for Ease of Use

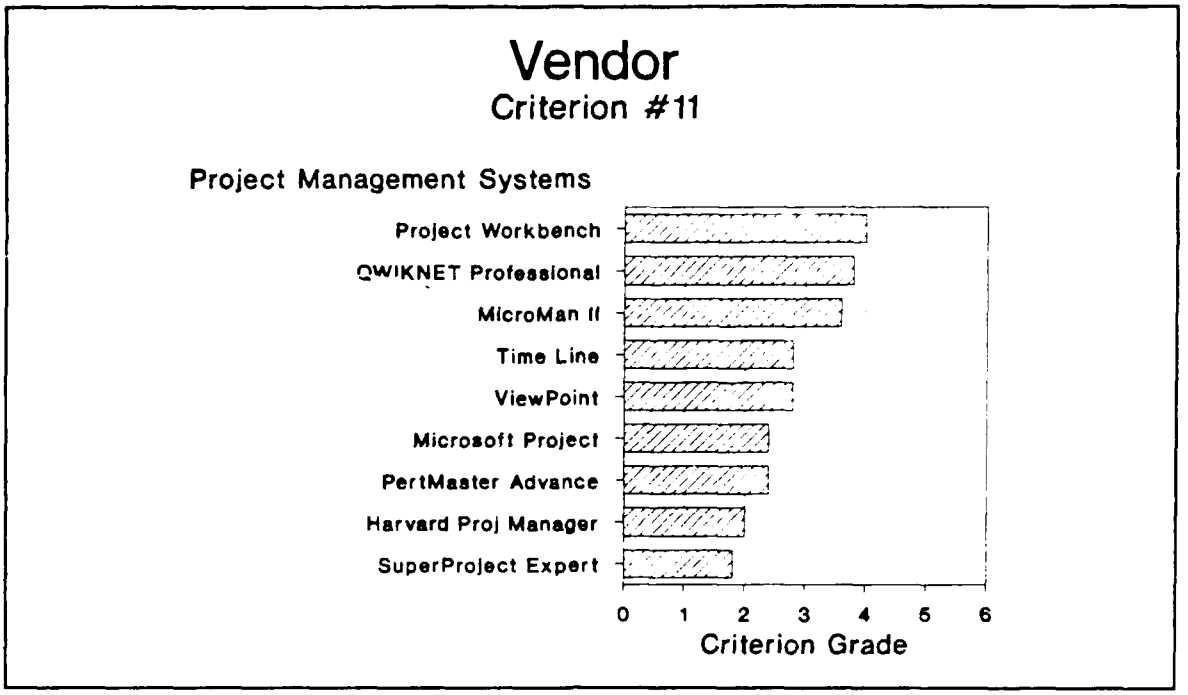

Figure 13 - Ranked Grades for Vendor

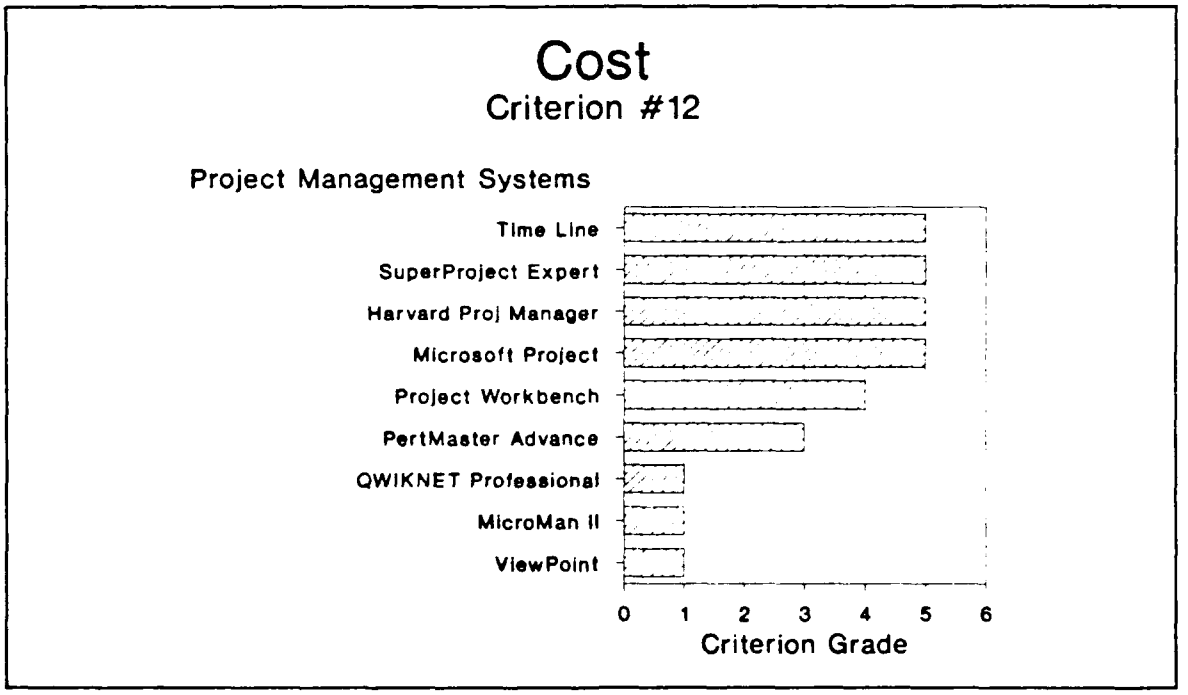

Figure 14 - Ranked Grades for Cost

4. Which of the software packages available are most appropriate for use by AFSC project managers? The results of the evaluation show that Time Line V3.0 is the most desirable software package for AFSC project management use. This is based on the criteria and relative weights used in the evaluation. Time Line should not automatically be assumed to be the most desirable system for all project management applications -- the best system will depend on the needs of the users. For AFSC project managers, ease of learning, ease of use, and cost were of primary importance (see weightings in Table 4). For other organizations and uses, different factors may be given greater importance, causing a new leader to emerge from the pack.

It is imperative that any organization using this evaluation methodology thoroughly examine the need for a new system. An accurate needs assessment allows criteria to be selected and weighted based on the intended use; no one set of criteria will apply to all possible applications. The approach used in this study is solid for AFSC, and possibly for the entire Air Force and Department of Defense (DoD). The researcher makes this assumption because the Air Force and DoD environments are similar in that there is a high rate of turnover between jobs, thus making an easy to learn and use system more desirable. Additionally, with severely limited organizational expenses, the lowest cost system providing the required functionality is most desirable.

5. What are the best methods for properly educating project managers on the use of the recommended software? The evaluation was structured such that ease of learning was very important. By examining the results of the Time Line Phase III - Stage 4 evaluation (see Table 18 and Figure 11), one sees that Time Line received a score of "excellent" for the sub-criteria within the Ease Of Learning criterion. The Time Line system has a "Getting Started" manual and tutorial that is both easy to learn and user-friendly, making it very easy for individuals to learn on their own.

It is suggested that each organization assign a focal point for the use of their project management system. Most organizations currently have a computer resources focal point, and if the individual is a program manager it should be fairly painless to be self-taught in Time Line and provide guidance to others where and when it is appropriate. Since Time Line is the easiest software package to learn and use, individuals should have little trouble quickly developing a preliminary understanding and enhancing their productivity. A users group should then be formed in order to create an open forum for discussing problems and successes, as well as to encourage the more experienced users to provide follow-up training.

6. What are the most effective means of implementing the recommended software throughout AFSC? Since Time Line is listed on the General Services Administration (GSA) schedule, it is very easy for individual organizations to purchase as many copies as are needed. This helps to ensure that the Government is receiving a fair price.

However, merely making the product available is not the solution. Project managers throughout AFSC, the Air Force, and DoD must be told of and sold on the value of personal computer-based project management systems. Many project managers have suffered from previous bad experiences with project management software that was forced on them (e.g., SYSNAS and AMIS). The older systems were high on structure and low on functionality and friendliness. Users must be convinced of the benefits provided by the new generation of hardware and software that is flooding the market. A project management system should not be looked upon as a rival or a waste of time, but rather it should be viewed as a team member that can handle all the time-consuming and mundane computational, graphic, and reporting work.

Overall Conclusions

The most important immediate conclusion to be drawn from this study is that Time Line V3.0 is the best software system on the market for AFSC project management use. It is the undisputed leader in the areas that are most important to the intended audience. However, the importance of this conclusion fades quickly with time. As newer and better hardware and software is developed, the need to re-assess the adequacy of Time Line will grow. In this apparent drawback lies the strength of this research.

The lasting result to be taken from this study is the methodology for evaluation of project management systems. By building on previous research, this thesis has developed a thorough, dependable approach for evaluating these systems. The most important point of the methodology is that the evaluation must be tailored to the needs of the organization. The project management software market is too broad to have one system that is best for every application. Each system is different and caters to differing needs -- that is why a proper needs assessment is vital for accurate selection and use of project management systems.

Tremendous potential exists in personal computers and project management software. Project managers must be convinced that this tool will greatly increase their productivity and allow them more time to deal with the qualitative aspects of their job.

Recommendations for Further Study

A primary goal of all scientific research is to extend the existing knowledge base beyond the boundaries it inhabited before the start of the study. One of the best ways to accomplish this is through programmatic research. This type of research builds on previous studies; in other words, it "picks up where someone left off." This allows lengthy, detailed studies to be performed by a team of individuals who sequentially work on the project for a short time relative to the entire study.

That was the intention of this thesis effort. It combined the work of three other theses, and established a foundation for the use of project management software. An interim conclusion was reached as to the best project management system at the point in time that the study was accomplished. However, this thesis is not the end of the cycle; it must be used as a stepping stone to further the krowledge and acceptance of computerizing project management, both inside and outside AFSC. Therefore, four recommendations for further study are made in the following paragraphs that will prove helpful to the overall concept of computerized project management.

Lessons Learned. First, a study should be accomplished which collects information on all the lessons learned from implementing, or attempting to implement, project management systems within Air Force and DoD organizations. As was

previously stated, mainframe software programs such as SYSNAS and AMIS have received less than resounding accolades for their contribution to the project management community. It would be helpful to determine why such systems have failed, and what the target audience feels should have been done differently. This would allow the role of project management software to be more narrowly defined, focusing on the areas where it can be most helpful. The study should also uncover possible implementation problems, such as forcing software use upon managers that do not feel it is worthwhile, thereby creating extra work and resentment.

Needs Analysis. Second, a thorough needs analysis should be conducted on a larger group of project managers. The researcher may wish to consider using a survey instrument to determine the information processing needs of prcject managers throughout the Air Force. A study of this nature should also focus on the attitudes and feelings that currently exist toward the use of computers in project management. As was previously stated, a thorough needs analysis is imperative for precise selection of evaluation criteria.

Validate Methodology. Once valid needs have been established for the larger group, the evaluation criteria should be re-examined to determine their adequacy. Armed with relevant criteria, the evaluation proposed in this thesis should be rerun with the intent of validating the

methodology. Even if a new needs analysis was not performed, rerunning the evaluation individually or through the use of a team would lend more credibility to this thesis effort.

Experiment. After the first three areas have been accomplished, an experiment should be developed involving a test group of project managers. These managers should be given and taught the software system that has been evaluated as being best for their use. They should be given approximately one-half year to use the software in their normal jobs, with the researcher keeping communication channels open in an attempt to prevent frustration and confusion. At the end of the experimental period, the researcher should examine two areas. First, evaluate the end result. Was the system a helpful tool? Would the managers continue to use it? Second, determine what stages the managers passed through on their way to the end result. Did they start off enthusiastic and end up dismayed? Were they apprehensive and ended up convinced? A study of this type would be very helpful in evaluating the human element in computerized project management.

Summary

This thesis effort has demonstrated a dependable methodology for evaluating project management software systems. At the time the study was conducted, Time Line version 3.0 by Symantec Corporation was determined to be the most desirable system for AFSC project managers to use. However, this thesis has just scratched the surface. Many negative feelings exist concerning computerized project management within AFSC, and these are difficult hurdles to overcome. It is hoped that this thesis will serve as an impetus for other studies, thereby promoting proper education, selection, and use of these software systems. If handled correctly, project managers will grow to understand and embrace the power and flexibility that project management software brings to the workplace.

Appendix A: All Known Commercially Available Project Management Software Packages (and Vendors) that meet the Initial Selection Criteria

VENDOR	##. PACKAGE NAME VERSION	COST
AccuraTech, Inc. Houston, TX (713) 960-9385	1. TIMETABLE V4.90	$6,500.
AGS Management Systems, Inc. King of Prussia, PA (215) 265-1550	2. PC-WINGS V1.4	$9,500.
	3. PAC MICRO V1.4	$1,485.
Ajida Technologies, Inc. Santa Rosa, CA (707) 545-7777	4. Topdown Project Planner V1.06	$ 95.
AlderGraf Systems, Inc. Houston, TX (713) 467-8500	5. AlderGraf Scheduling System V4.1	$ 975.
Andrew Sipos Associates New York, NY (212) 321-2408	6. ASAPMS/Housekeeper V18.1	$ 723.
Applied Business Tech. Corp. New York, NY (212) 219-8945	7. Project Workbench-Advanced V3.0	$1,275.
	8. Project Workbench-Standard V2.2	$ 750.
Applitech Software, Inc. Cambridge, MA (617) 497-8268	9. Skyline V1.0	$ 295.
Bechtel Software, Inc. Acton, MA (508) 635-0580	10. Panorama V4.8	$5,200.
Chronos Software, Inc. San Francisco, CA (800) 777-7907	11. Who-What-When V1.09	$ 190.

Communication Dynamics, Inc. Portland, OR (503) 684-5151	12. Timepiece V1.3	$ 495.
Computer Aided Management Petaluma, CA (800) 635-5621	13. ViewPoint V3.1	$2,990.
Computer Associates Int. San Jose, CA (800) 533-2070	14. SuperProject Expert V1.1	$ 695.
	15. SuperProject Plus V3.0	$ 395.
Computerline, Inc. Pembroke, MA (800) PLAN-123	16. PlanTRAC Mark 4B VM4B	$4,500.
	17. PlanTrac/1 V4B	$1,690.
Data Consulting Group Novato, CA (415) 883-2300	18. Data*Easy Project Scheduler V2.5	$ 75.
DEKKER LTD Redlands, CA (714) 793-7939	19. Dekker Trakker Plus V2.30	$6,250.
	20. Dekker Trakker V2.30	$2,995.
	21. Dekker Trakker Junior V2.25	$ 395.
DEMI-Software Ridgefield, CT (203) 431-0864	22. DEMI-Plan V4.0	$ 40.
Digital Marketing Corp. Walnut Creek, CA (415) 947-1000	23. Milestone V1.14	$ 99.
Diversified Info. Services Studio City, CA (800) 333-1979	24. AMS Time Machine V2.2	$4,500.
Earth Data Corp. Richmond, VA (804) 231-0300	25. MicroGantt V1.95	$ 295.

Elite Software Devel. Corp. Bryan, TX (409) 846-2340	26. CPM/PERT Program V3.1	$ 249.
Frontline Systems, Inc. Palo Alto, CA (415) 327-7297	27. Project Calc/Resources V2.0	$ 280.
Gantt Systems, Inc. Piscataway, NJ (201) 968-9550	28. GANTT-PACK Work Processor V3.5	$ 225.
Information Research Corp. Charlottesville, VA (800) 368-3542	29. SYZYGY V1.0	$ 395.
Inmax Vancouver, British Columbia (604) 682-8700	30. Project:Vision Level 2 V1.1	$ 648.
InstaPlan Corp. Mill Valley, CA (800) 852-7526	31. InstaPlan V2.0	$ 369.
K&H Professional Mgmt Serv Wayne, PA (215) 341-8800	32. PRESTIGE PC V3.0	$5,000.
MC2 ENGINEERING SOFTWARE Miami, FL (305) 665-0100	33. Critical Path Project Mgmt V8702	$ 295.
McDonnell Douglas Info Sys Hazelwood, MO (800) 325-1551	34. MSCS Micro V9.1	$9,995.
Metier Mgmt Systems, Inc. Houston, TX (800) 777-7100	35. Artemis Project 2000 V2.1.5	$6,000.
Micro-Frame Technologies Ontario, CA (714) 983-2711	36. Micro-Frame Project Manager V1.5	$7,500.
Micro Planning International San Francisco, CA (415) 788-3324	37. Micro Planner (4000) V4.3	$2,245.
	38. Micro Planner (2000) V4.3	$1,595.

	39. Micro Planner for Windows V6.10a	$ 595.
	40. Micro Planner (500) V4.3	$ 495.
Micro Research Systems Corp. Montreal, Quebec (514) 487-2275	41. PROJECT/1-80 V3.00	$ 800.
Microsoft Corp. Redmond, WA (800) 426-9400	42. Microsoft Project 4.0 V4.0	$ 495.
Mitchell Management Systems Westborough, MA (800) 222-9886	43. MAPPS-PC V1.0	$5,000.
	44. Quick Plan II V1.25	$ 250.
Monenco Info. Systems, Inc. Calgary, Alberta (403) 298-4170	45. MPMS:PERT6 V3.1	$5,000.
Monitor Software Los Altos, CA (800) 367-7879	46. TASK MONITOR - PC V4.2	$1,190.
Morgan Computing Co., Inc. Carrollton, TX (214) 991-7598	47. EasyGantt V1.0	$ 49.
Multitrak S/W Develop. Corp. Boston, MA (617) 428-6677	48. MULTITRAK V2.5	$6,500.
National Info. Systems, Inc. San Jose, CA (408) 985-7100	49. VUE V6.15	$2,090.
North America Mica, Inc. San Diego, CA (619) 792-1012	50. PMS-II (with RMS-II) V8.1	$2,785.
	51. PMS-II V8.0	$1,790.
Pinnell Engineering, Inc. Portland, OR (503) 243-2246	52. PMS 80 Advanced V5.26	$4,495.

POC-IT Mgmt Services, Inc. Santa Monica, CA (213) 393-4552	53. MicroMan II V1.1	$2,990.
Power Project Management La Jolla, CA (619) 546-2939	54. Integrated Proj Mgmt Sys V2.2	$4,000.
Primavera Systems, Inc. Bala Cynwyd, PA (800) 423-0245	55. Finest Hour V3.0	$5,000.
	56. Project Planner V3.20	$4,000.
Productivity Solutions, Inc. Waltham, MA (617) 894-7800	57. Project Cost Model V4.08d	$ 500.
Professional Applications San Diego, CA (619) 560-5614	58. PERT+ V87.04	$1,095.
Proj Planning, Mgmt & Ctrl Burnsville, MN (612) 431-1942	59. Netcon I and II V2.0	$ 595.
Projectronix Los Altos, CA (800) 543-5938	60. PertMaster Advance V2.1	$1,990.
Project S/W & Develop, Inc. Cambridge, MA (800) 231-PSDI	61. QWIKNET Professional V1.20	$2,690.
	62. QWIKNET 2.0 (500) V2.0	$ 895.
SBT Corp. Sausalito, CA (800) 227-7193	63. dProject V6.2	$ 395.
SCITOR Corp. Foster City, CA (415) 570-7700	64. Project Scheduler 4 V1.5	$ 685.
	65. Project Scheduler 5000 V3.0	$ 425.
Sheppard Software Company Redding, CA (916) 222-1553	66. MicroPERT 1 V2.1	$ 350.

	67. MicroPERT 0 V3.3	$ 250.
Shirley Software Systems South Pasadena, CA (818) 441-5121	68. MISTER-PC V7	$5,000.
Simple Software Irvine, CA (714) 857-9179	69. ProjectMaster V3.0A	$ 399.
SoftCorp, Inc. Clearwater, FL (800) 255-7526	70. Pro*Path*Plus P.M. System V1.1	$ 495.
Softext Publishing Corp. New York, NY (212) 986-5985	71. Scheduling & Control V2.01	$ 95.
SofTrak Systems, Inc. Salt Lake City, UT (801) 973-9610	72. MicroTrak V1.7	$ 890.
Software Publishing Corp. Mountain View, CA (415) 962-8910	73. Harvard Project Manager V3.01	$ 695.
Strategic S/W Planning Corp. Cambridge, MA (800) SSP-DATA	74. Promis V3.0	$2,995.
	75. Project Outlook V3.0	$ 695.
Symantec Corp. Cupertino, CA (408) 252-3570	76. Time Line 3.0 V3.0	$ 790.
Systonetics, Inc. Fullerton, CA (714) 680-0910	77. VISIONmicro V2.2.2	$1,990.
Technical Economics, Inc. Berkeley, CA (415) 525-7774	78. VUE Project Mgmt System V6.15	$1,995.
Welcom Software Technology Houston, TX (713) 558-0514	79. OPEN PLAN V3.2	$4,200.

Appendix B: Expert Panel Members

Member/Grade/Position(s)	Office Symbol/Phone
Harold Casey, GM-14 Directorate Chief, SAC/TAC Electronic Warfare Systems	MSD/YIH Eglin AFB, FL 32542 AV: 872-9261
Clifton Doiron, GM-15 Dep SPO Director, Advanced Decision Systems	ESD/AV Hanscom AFB, MA 01731 AV: 478-6154
Robert Hartnett, Capt Program Manager, Computer Engineer, TAC Threats	AFIT/LSG Wright-Patt AFB, OH 45433 AV: 785-5435
David Maloney, Capt Chief of Automation, Integration, & Plans Branch	MSD/ACP Eglin AFB, FL 32542 AV: 872-4051
Richard Painter, Capt Computer Engineer, Aerial Targets	MSD/YIQ Eglin AFB, FL 32542 AV: 872-5124
Richard Peschke, LtC Assistant Professor of Logistics Management	AFIT/LSQ Wright-Patt AFB, OH 45433 AV: 785-4845
Daniel Reynolds, Civ Assistant Professor of Computing Sciences	AFIT/ENC Wright-Patt AFB, OH 45433 AV: 785-8532
Charles Stansberry, Capt Small Computer Support Center	ASD/SC Wright-Patt AFB, OH 45433 AV: 785-8001
Virginia VonHaven, GS-12 Developmental Engineer	6585 TESTG/GDE Holloman AFB, NM 88330 AV: 349-1582
Rodney Wilkinson, Capt Program Manager, TAC Threat Simulation Systems	MSD/YIS Eglin AFB, FL 32542 AV: 872-8351

Appendix C: Minor Project Used for the Phase III - Stage 3 Evaluation

Synopsis

The project described in this appendix was used in the Phase III - Stage 3 (Minor Project) evaluation portion of the study. In the search for a minor project, one was desired that had between 30 and 50 activities. This is the size allowed by most limited demonstration versions of project management software. A project of that size is large enough to allow meaningful information to be generated by the software, yet small enough that it can be entered quickly into the system. The project chosen is actually the original schedule used to complete this AFIT thesis.

The Gantt Chart shown in Figure 15 lists the activities necessary to accomplish the objective, as well as the individuals responsible for them. The approximate duration of each task is also given along with an indication of the status (i.e, 'R' indicates some form of resource conflict, while 'C' indicates a critical task). The intertask dependencies can be viewed on the Gantt Chart by examining task start dates that are tied to previous task completion dates, in other words, examine the cascading (or waterfall) effect of the task durations.

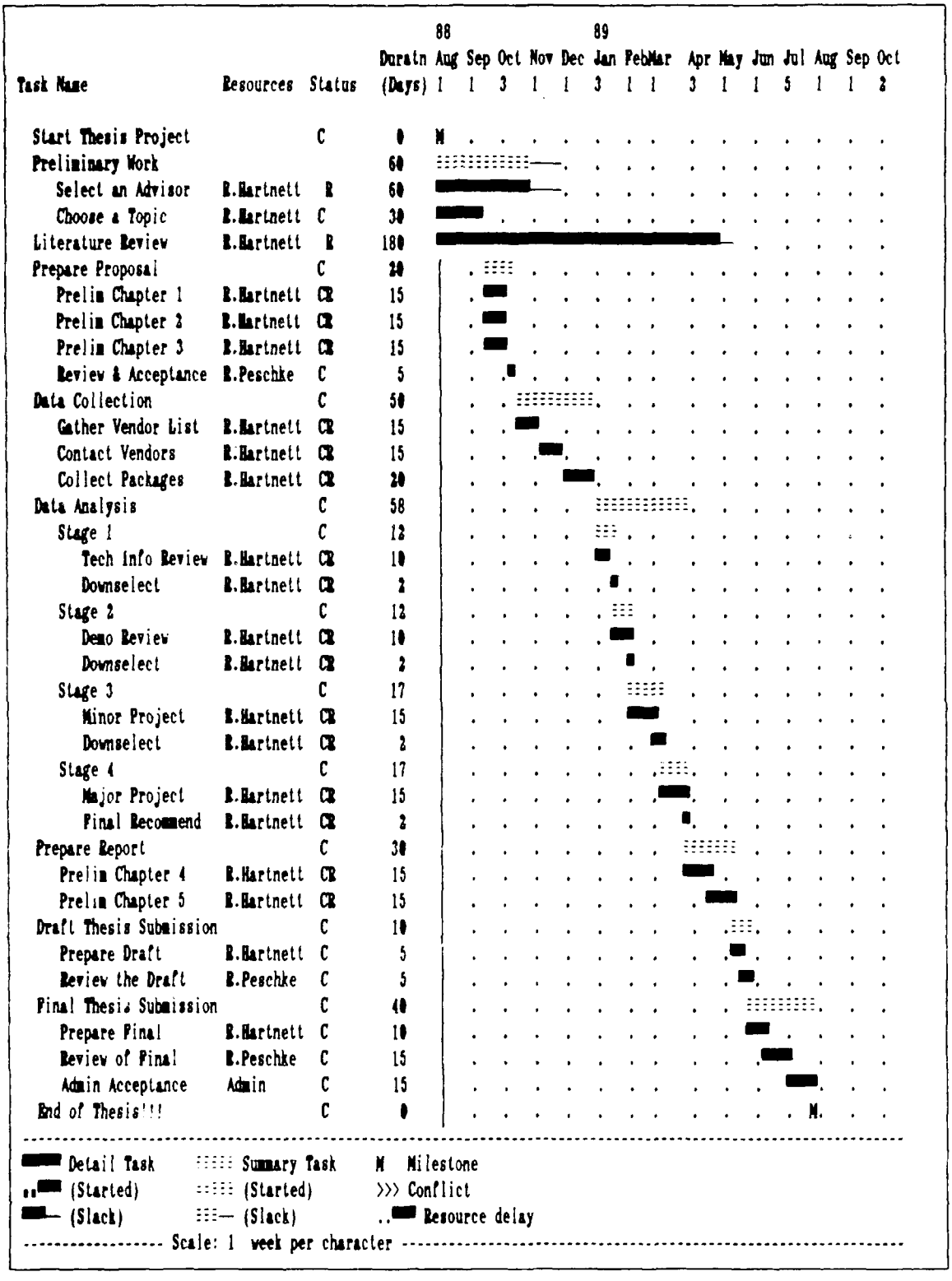

Figure 15 - Gantt Chart of Minor Project

Appendix D: Major Project Used for the Phase III - Stage 4 Evaluation

Synopsis

This appendix gives an overview of the project used in the Phase III - Stage 4 portion of the software evaluation. Realism was the primary objective in choosing the project for this stage, since each software package making it to the final stage would receive the same use that it would in an AFSC program office. Therefore, a project that the researcher worked on for four years prior to attending AFIT was chosen. It is recommended that any future researchers using this evaluation methodology first attempt to use a project that they are intimately familiar with in order to bypass the need to learn the intricacies of this project. However, if one is not available, then this project can be used.

The project is called the On-Board Electronic Warfare Simulator, and it is broken down into three configuration items: 1) the On-Board Subsystem (OBS), 2) the Ground Support Subsystem (GSS), and 3) the Special Test Equipment Subsystem (STES). The OBS is a sophisticated computer system within a pod that hangs on the wing of an aircraft. The computer injects signals into the radar warning receiver of the aircraft when the aircraft reaches certain locations, thus giving the pilot the impression that he/she is either being tracked or attacked. If the pilot takes the correct

defeat procedures, the threat is removed from the scope. The computer records the entire mission and allows the pilot play it back at the GSS ground station. This GSS is also used to program the mission before flight. The STES is used for diagnostic purposes. This system provides pilots with electronic warfare training capability anywhere in the world -- without requiring the use of a range.

Figure 16 shows the first level breakdown of the project as well as summary durations. A plus sign (+) next to a major subsection indicates that it is a 'hammock', which is actually a collection of all the activities within that subsection. The total duration of all the activities within a hammock determines its duration, since it is not an actual activity. The detailed outline that follows in Table 20 was the initial plan used to manage the Phase II Prototype Development effort for OBEWS. Additionally, these resources were assigned various programmatic responsibilities: program manager, lead engineer, computer engineer, two general engineers, logistics manager, test manager, contractor, Air Training Command representative, and using command representative. The resources are responsible for the areas they are listed next to as well as all sub-levels unless otherwise specified.

Most of the information presented in this appendix is intentionally at the executive summary level in order to give readers and researchers a taste of the major project and not

inundate them with trivial project data. There are almost 300 activities listed in the outline. Most of the areas listed in the outline could be broken out further, and indeed they were as the project progressed. As was previously stated, planning is an iterative process, and the schedule should continually be refined to reflect the most current information and estimates.

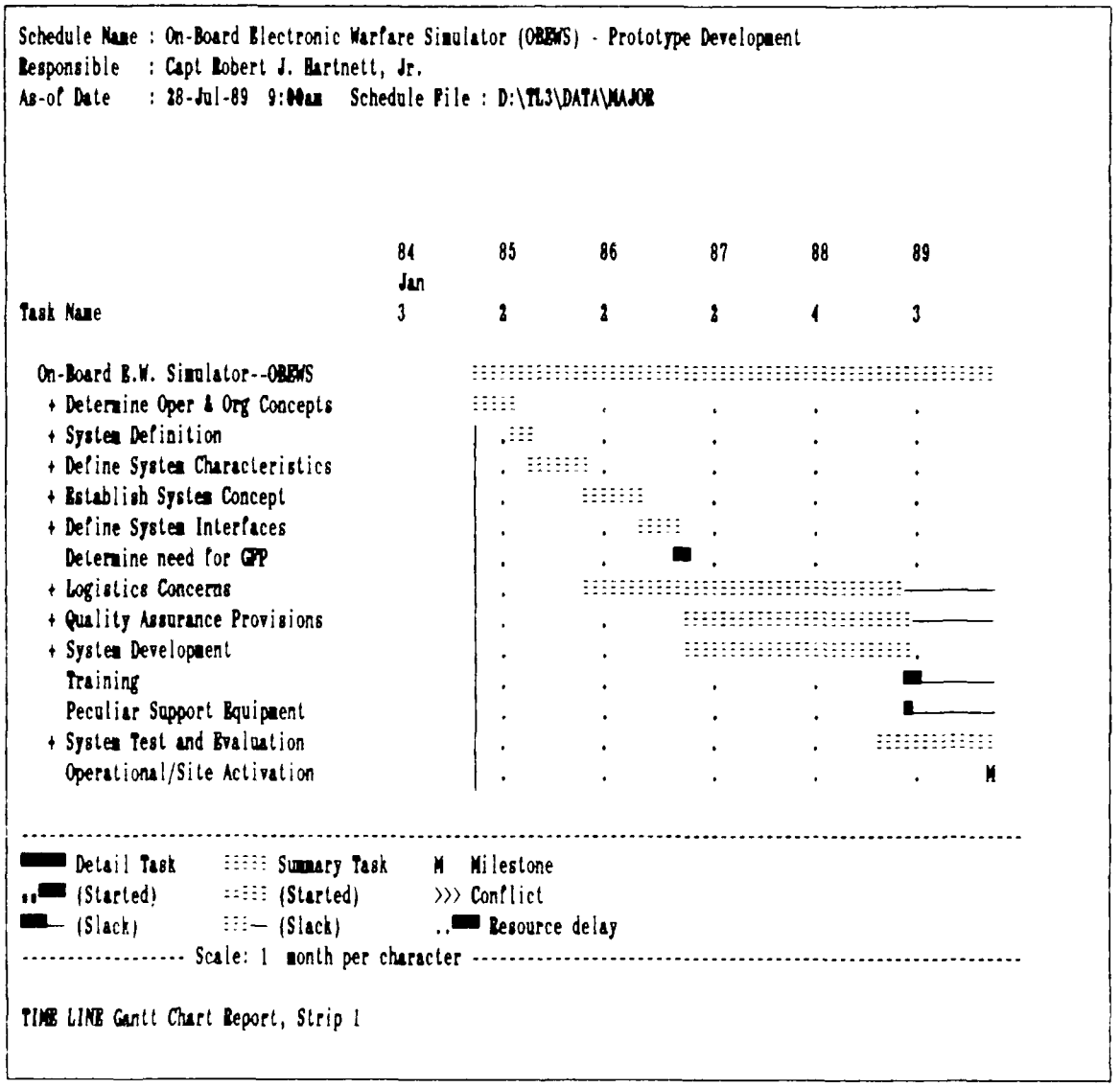

Figure 16 - Gantt Chart of Major Project

Table 20 - Task & Resource Outline for Major Project (p. 1/4)

Schedule Name : On-Board Electronic Warfare Simulator (OBEWS) - Prototype Development
Responsible : Capt Robert J. Hartnett, Jr.
As-of Date : 28-Jul-89 9:00am Schedule File : D:\TL3\DATA\MAJOR

Task Name	Resources
On-Board E.W. Simulator--OBEWS	
Determine Oper & Org Concepts	Prog Mgr, Lead Engr, Log Mgr, Test Mgr, User
Event Training	
Multi-Ship Operation	
Training Areas	
System Definition	Prog Mgr, Lead Engr, Contractr
Mission Definition	
Pre-Mission Phase	
Flight Phase	
Post-Mission Phase	
Define System Characteristics	User, Prog Mgr, Lead Engr, Comp Engr
Performance Constraints	Lead Engr, Engr 1, Comp Engr
Programming	Comp Engr, Engr 2
Mission Scenario Programming	
Computing	Comp Engr, Engr 2
OBS Outputs	
Simulation Characteristics	
Ground-Based Threat Simulation	
Airborne Intercept Simulation	
Mission Parameters	Lead Engr, Engr 1, Comp Engr, Prog Mgr
Position Accuracy	
Global Positioning System	
OBS Navigation System Accuracy	
Other Accuracies	
Attitude	
"G" Loading	
Ground Speed	
ECM Employment Monitoring	Lead Engr, Engr 1
Jamming	
Chaff/Flares	
Maneuvers	
Tactics	
Mission Recording	Lead Engr, Comp Engr
RWR Display	
Mission Flight Data	
ECM Switch Action	
RWR Parametric Audio	
Aircrew Debriefing	User, Lead Engr
Visual Displays	
Audio Presentation	
RWR Display	
Control of System	Lead Engr, Engr 1
Aircrew Control	
Automatic Control	
Checkout and Calibration	Lead Engr, Engr 1
Testability	
Preflight Testing	
Built-In-Test (BIT) Capability	
Calibration	

Table 20 - Task & Resource Outline for Major Project (p. 2/4)

Physical Constraints	Lead Engr, Engr 1, Log Mgr
Internal Subsystems	
Dimension & Location Restrictn	
Weight Restrictions	
Electrical Power	
Pob-mounted Subsystems	
Dimensional Requirements	
Mass Properties	
Drag Requirements	
Physical Fit	
Security Criteria	
Classification	
Electromagnetic Emanations	
Reliability Constraints	Lead Engr, Log Mgr
MTBF	
Maintainability Constraints	Lead Engr, Log Mgr
Quantitative Maintainability	
On-Equipment	
Off-Equip	
LRU Repair	
Availability Constraints	Lead Engr, Log Mgr
Environmental Constraints	Lead Engr, Engr 1, User
OBS Environmental Conditions	
GSS Environmental Conditions	
STES Environmental Conditions	
Transportability Constraints	Lead Engr
Establish System Concept	Prog Mgr, Engnring, Contractr, Log Mgr, Test Mgr
On-Board Subsystem (OBS)	Lead Engr, Engr 1, Contractr
AN/ALR-69 RWR Processor	
Inputs	
Freq Select Respons Sys (FSRS)	
Transmission Line Couplr (TLC)	
Control System	
Outputs	
Audio -- to headset	
Video -- to Display	
OBS Processor	Comp Engr, Engr 2, Lead Engr
Inputs	
Audio Digitizer	
Audio Generator	
EEPROM Module	
Inertial Navigation System	
OBS Module	
Occulting Processor	
Transmission Line Couplr (TLC)	
Outputs	
Audio Generator	
EEPROM Module	
Occulting Processor	
Transmission Line Couplr (TLC)	
Occulting Processor	Comp Engr, Engr 2, Lead Engr
Inputs	
EEPROM Module	
OBS Processor	
Outputs	
OBS Processor	

Table 20 - Task & Resource Outline for Major Project (p. 3/4)

Ground Support Subsystem (GSS)	Comp Engr, Lead Engr, Engr 1, Engr 2
Wing GSS Configuration	
Computational Group	
Display Group	
OBS Record/Load Interface Grp	
OBS Record Interface Component	
OBS Load Interface Component	
Audio Interface Group	
Mass Storage Group	
TEMPEST Group	
Environment Group	
Depot GSS Configuration	
Computational Group	
Display Group	
Print Group	
OBS Record/Load Interface Grp	
OBS Record Interface Component	
OBS Load Interface Component	
Audio Interface Group	
Mass Storage Group	
TEMPEST Group	
Environment Group	
Special Test Equip Sub (STES)	Lead Engr, Engr 1
Define System Interfaces	Lead Engr, Comp Engr, Engr 1, Engr 2, A/C Integr
OBS - F-16 A/C Interfaces:	Lead Engr, Engr 1, A/C Integr
OBS pod as a store	
Data Converter Module	
Chaff/Flare Control Panel	
Communication Panel	
ECM Control Panel	
Avionics Mux Bus	
AN/ALR-69 RWR	
Stores Management System (SMS)	
GSS Interfaces:	Comp Engr, Engr 2, Lead Engr
Flight Data Recording	
Mission Data Storage	
STES Interfaces:	Lead Engr, Engr 1
OBS Processor	
Determine need for GFP	Log Mgr, Prog Mgr, Lead Engr
Logistics Concerns	Log Mgr, Lead Engr, Prog Mgr, Comp Engr
Maintenance	
Levels of Maintenance	
On-Equipment Maintenance	
Off-Equipment Maintenance	
Depot Maintenance	
Skill Levels	
Data Collection	
Failure Diagnostic Techniques	
Support Equipment	
Ground Support Operation	
Calibration Requirements	
Maintenance Manning/Personnel	
Software Maintenance	
Supply	
Facilities	

Table 20 - Task & Resource Outline for Major Project (p. 4/4)

Quality Assurance Provisions	Prog Mgr, Contractr, Engnring, Log Mgr, Test Mgr
Classification of Tests	
Inspections	
Computer Program Config Item	
Factory Acceptance Test	
Operational Acceptance Test	
Key Areas of Testing	
Physical Characteristics	
Reliability	
Maintainability	
Electrical Inspection	
Environmental	
Transportability	
Design and Construction	
Performance	
TEMPEST	
System Development	Contractr, Prog Mgr, Engnring, Log Mgr, Test Mgr
On-Board System (OBS)	
Integration and Assembly	
Sensor Equipment	
Communications Equipment	
Auto. Data Process. Equipment	
Processors/Computers Selection	
Selection Criteria	
Technical Justification	
Spare Capacity	
Peripherals & Peripheral Equip	
Computer Software End Item	
A/C Integrate, Compatib, & Mod	
Aircraft Integration	
Aircraft Compatibility	
Aircraft Modification	
Ground Support System (GSS)	
Integration & Assembly	
Communications Equipment	
Auto Data Processing Equipment	
Computer Programs	
Data Display Equipment	
Special Test Equipment Subsys	
Training	ATC, Prog Mgr
System Test and Evaluation	Test Mgr, Engnring, Contractr, Prog Mgr
Computer Program Config Item	Comp Engr, Engr 2, Lead Engr, Contractr
Subsystem Testing	Lead Engr, Engr 1, Contractr
In-Plant Acceptance Testing	Lead Engr, Engr 1, Contractr
Functional Config Audit I	Lead Engr, Comp Engr, Engr 1, Engr 2, Contractr
Physical Config Audit I	Lead Engr, Comp Engr, Engr 1, Engr 2, Contractr
Development Test & Evaluation	Test Wing, Lead Engr, Engr 1, Contractr
Functional Config Audit II	Lead Engr, Comp Engr, Engr 1, Engr 2, Contractr
Operational Test & Evaluation	User, Prog Mgr, Lead Engr
Physical Config Audit II	Lead Engr, Comp Engr, Engr 1, Engr 2, Contractr
Operational/Site Activation	Prog Mgr, Lead Engr, Comp Engr, Log Mgr, User

TIME LINE Activity Detail, Strip 1

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The purpose of this study was to determine what project management software systems are available to AFSC project managers, and to determine which of these systems are most appropriate for AFSC use. The study had three basic objectives:

1. Assessing the information processing deficiencies and desires of AFSC project managers.

2. Generating a flexible project management software evaluation methodology that could be used for this and future evaluations.

3. Determining which one or group of project management software systems would best meet these information needs.

Recent research showed that the information needs of AFSC project managers were not being met. A solid project management system was found to be a possible solution; therefore, a three-phase evaluation methodology was developed. The methodology was validated by a panel of ten experts who all had considerable experience in the fields of computer systems and project management.

The methodology started with a thorough literature review, passed through a data collection phase, and concluded with the data evaluation. The data evaluation phase was broken into four stages, each designed to have more stringent requirements imposed on the software packages under consideration. The last stage called for the actual use of each remaining software package in a manner similar to its intended use in the workplace.

The methodology was used to evaluate seventy-nine commercially available project management systems that could potentially meet AFSC needs. One system clearly stood out above the rest; however, this result could change as new software systems or versions are released. Therefore, the standout system was recommended to solve the short-term information processing problem, and the methodology used is offered as the long-term solution to inevitable future deficiencies.